FIG. 1

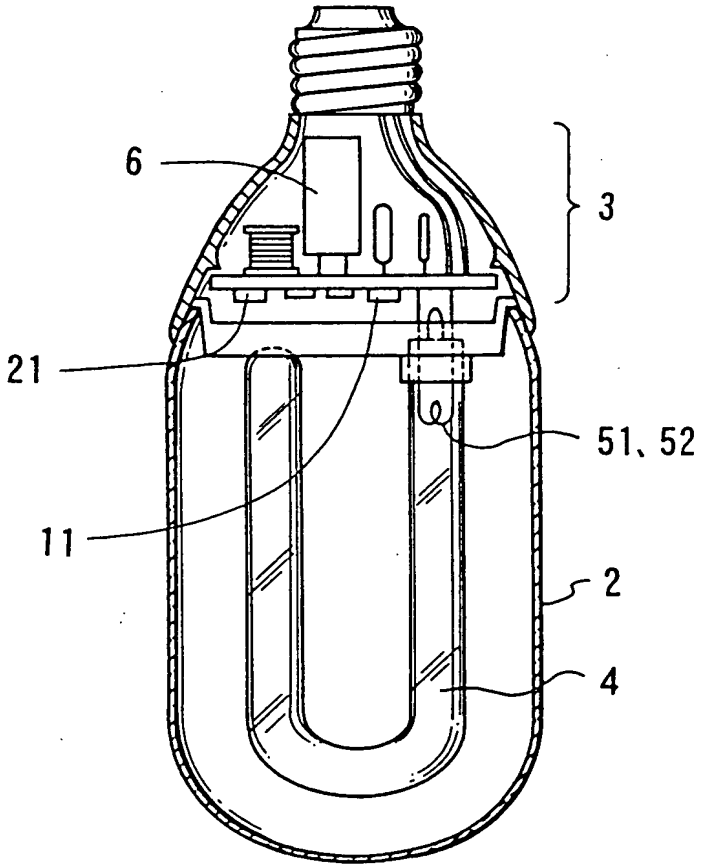


FIG. 2

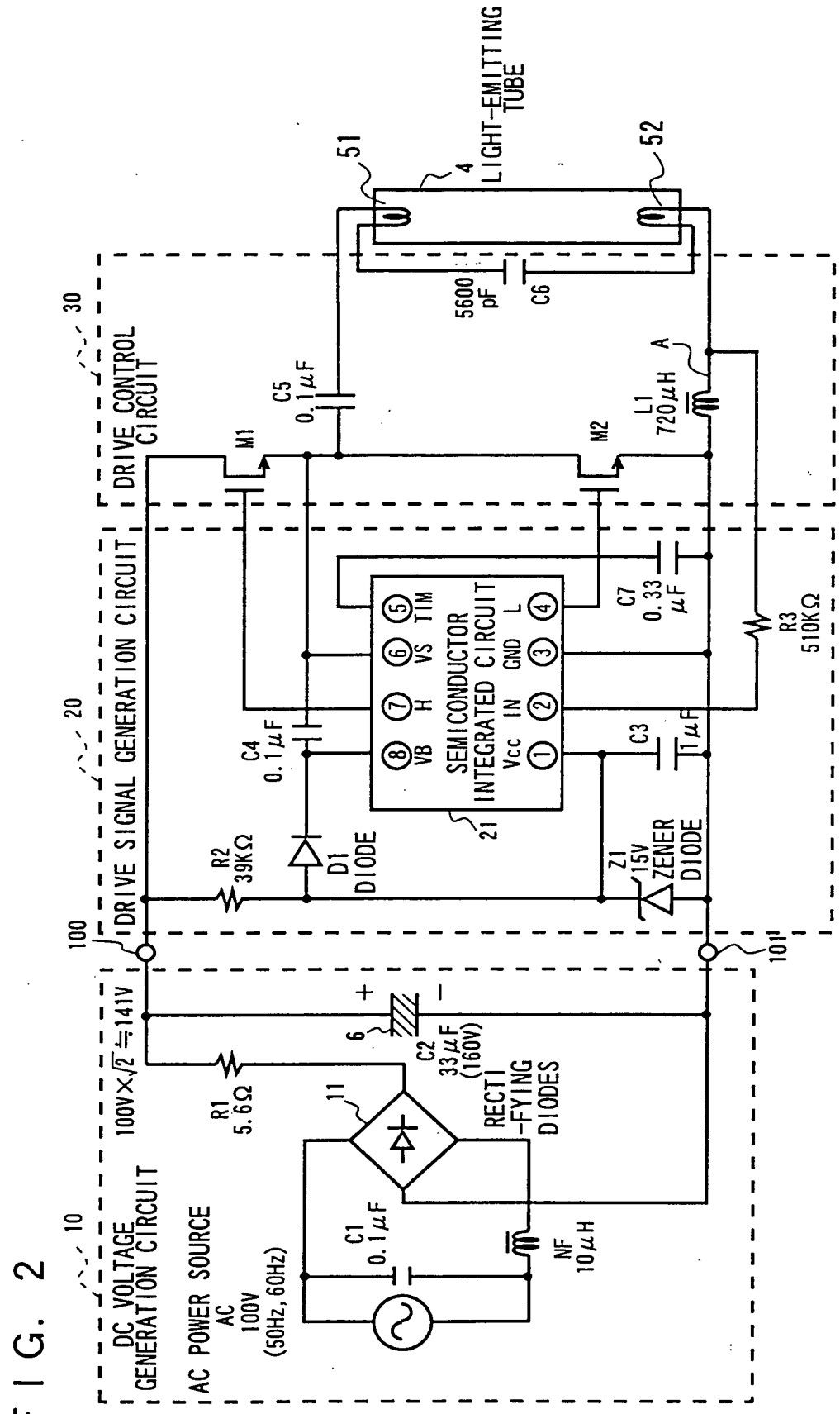

10
DC VOLTAGE GENERATION CIRCUIT
AC POWER SOURCE
AC 100V (50Hz, 60Hz)
100V×√2 ≒141V
R1 5.6Ω
C1 0.1μF
11
RECTI-FYING DIODES
NF 10μH
6
C2 33μF (160V)
20
DRIVE SIGNAL GENERATION CIRCUIT
R2 39KΩ
C4 0.1μF
D1 DIODE
SEMICONDUCTOR INTEGRATED CIRCUIT
21
Vcc IN H VB VS GND TIM L
Z1 15V ZENER DIODE
C3 1μF
C7 0.33μF
R3 510KΩ
30
DRIVE CONTROL CIRCUIT
C5 0.1μF
M1
M2
L1 720μH
A
4
LIGHT-EMITTING TUBE
51
52
5600pF
C6
100
101

FIG. 3

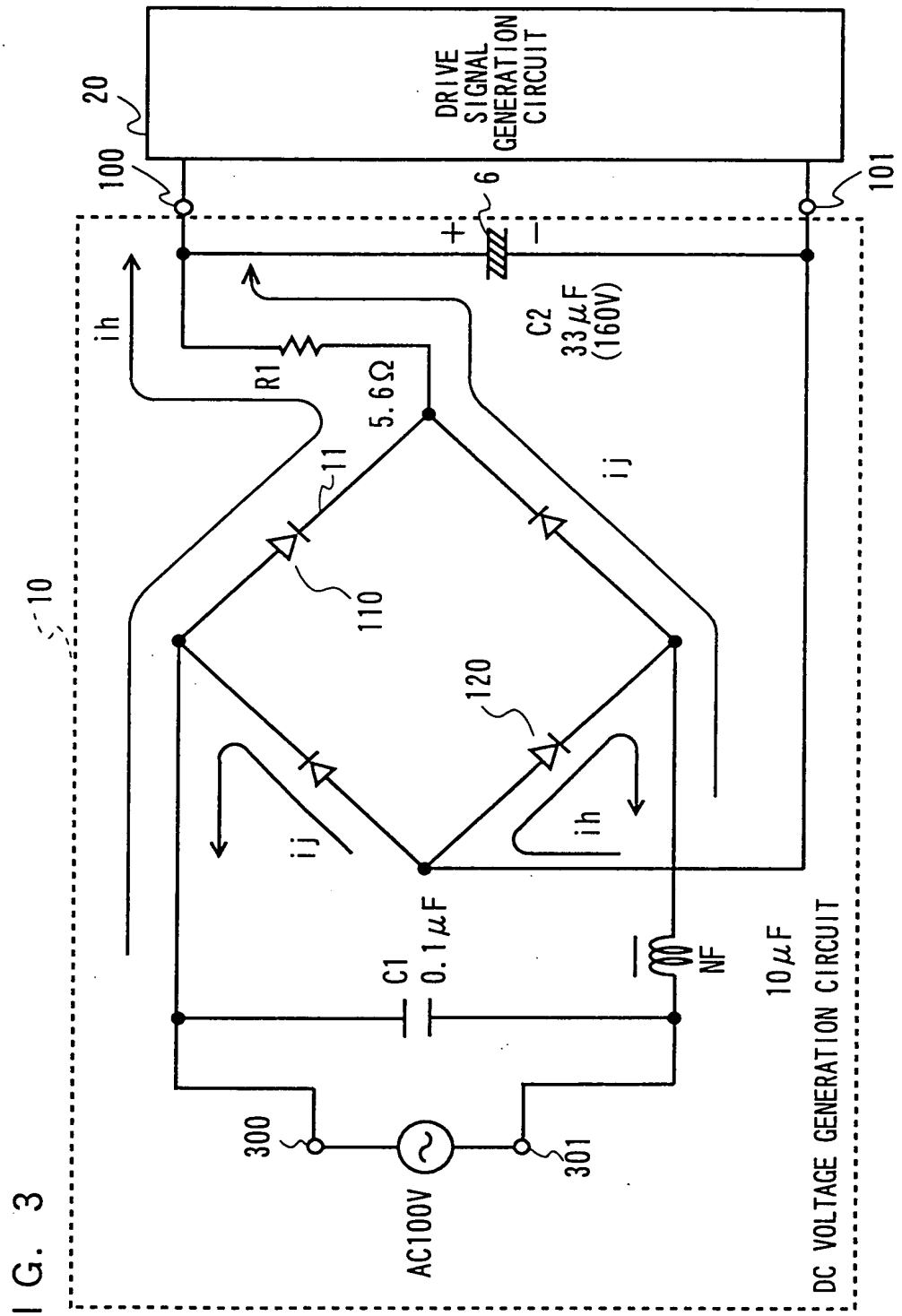

DRIVE SIGNAL GENERATION CIRCUIT
20
100
101
6
+
−
C2
33μF
(160V)
ih
R1
5.6Ω
11
110
120
ij
ij
ih
C1
0.1μF
NF
10μF
300
301
AC100V
10
DC VOLTAGE GENERATION CIRCUIT

FIG. 4

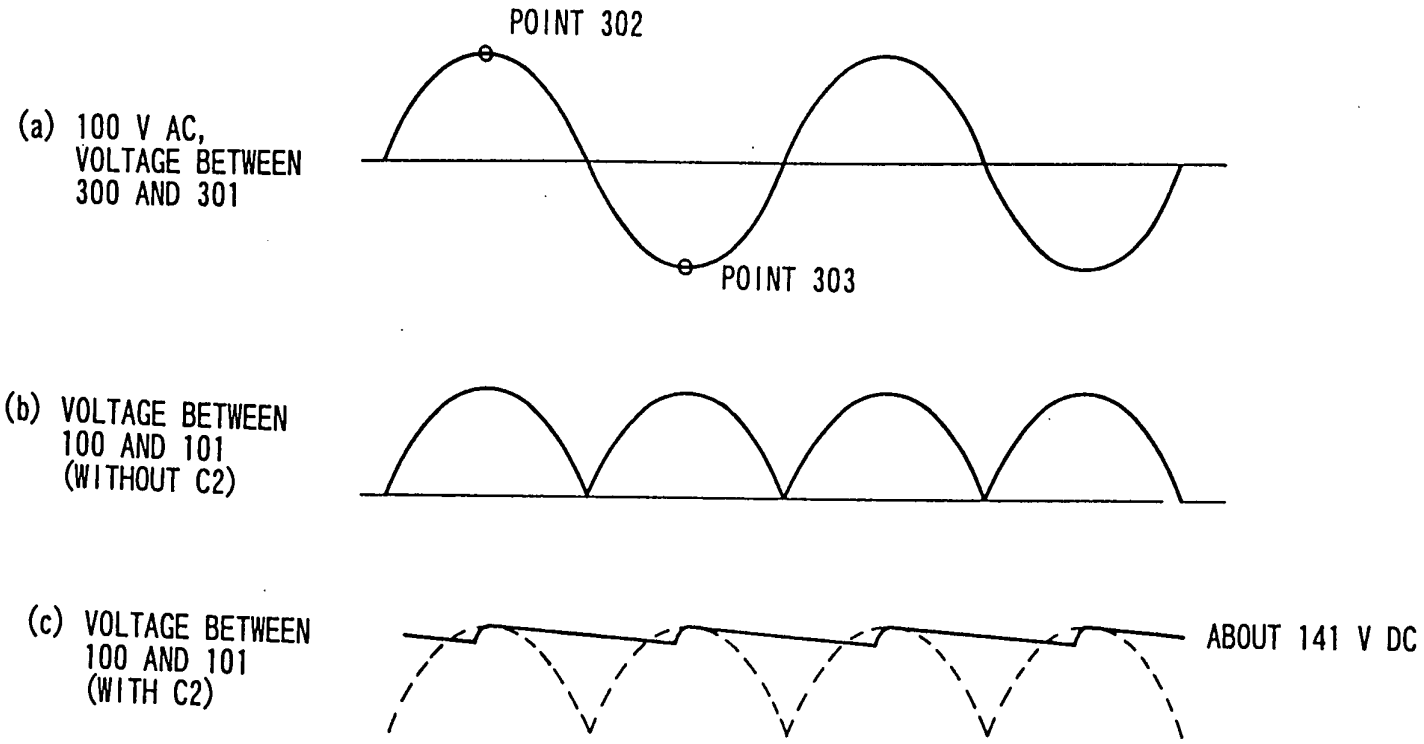

(a) 100 V AC, VOLTAGE BETWEEN 300 AND 301
POINT 302
POINT 303
(b) VOLTAGE BETWEEN 100 AND 101 (WITHOUT C2)
(c) VOLTAGE BETWEEN 100 AND 101 (WITH C2)
ABOUT 141 V DC

FIG. 5

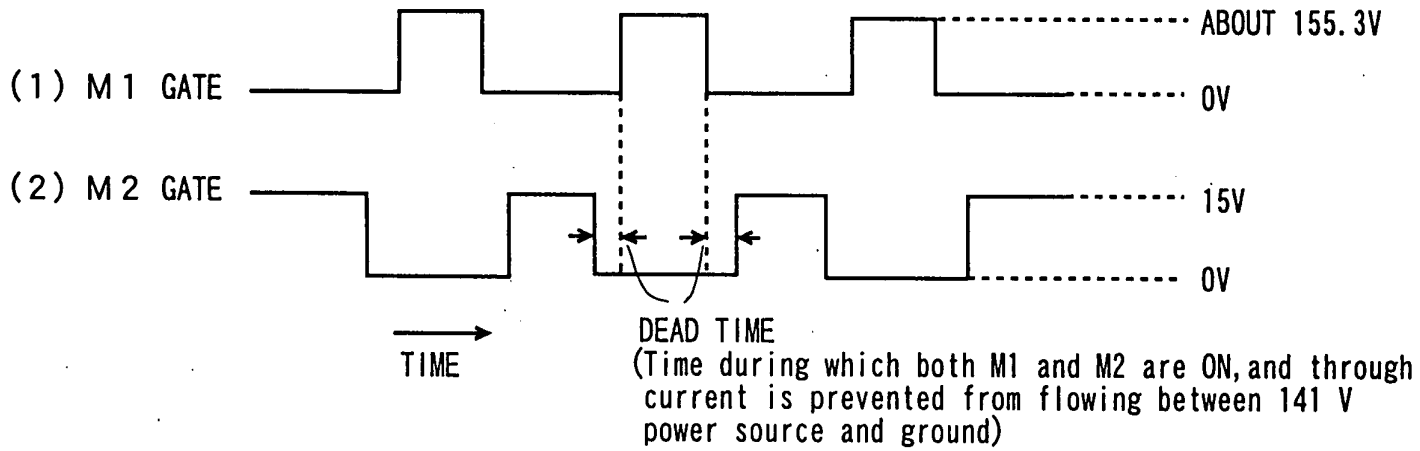

(1) M1 GATE
(2) M2 GATE
ABOUT 155.3V
0V
15V
0V
TIME
DEAD TIME
(Time during which both M1 and M2 are ON, and through current is prevented from flowing between 141 V power source and ground)

FIG. 6

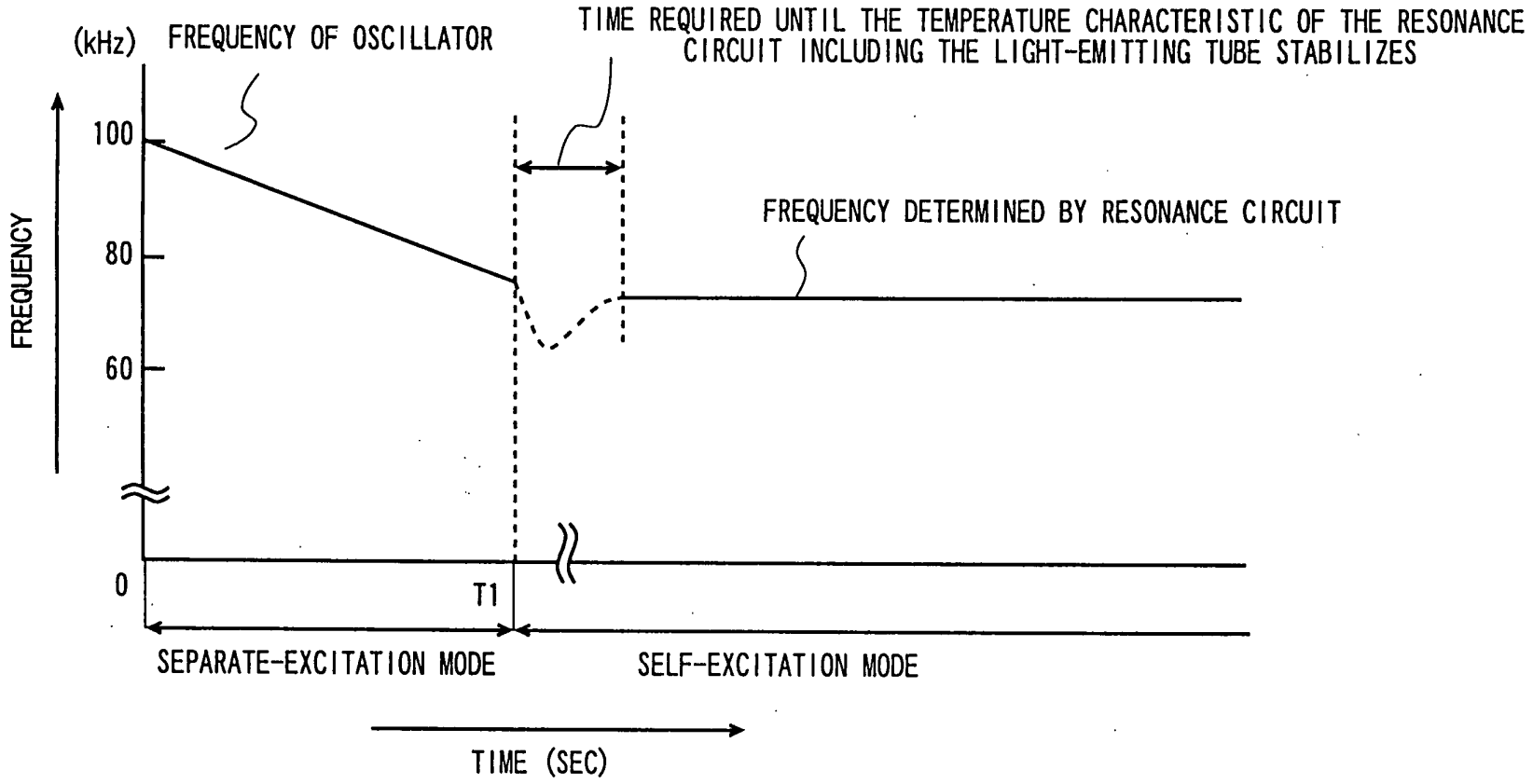

(kHz)
FREQUENCY OF OSCILLATOR
TIME REQUIRED UNTIL THE TEMPERATURE CHARACTERISTIC OF THE RESONANCE CIRCUIT INCLUDING THE LIGHT-EMITTING TUBE STABILIZES
FREQUENCY DETERMINED BY RESONANCE CIRCUIT
FREQUENCY
100
80
60
0
T1
SEPARATE-EXCITATION MODE
SELF-EXCITATION MODE
TIME (SEC)

FIG. 7

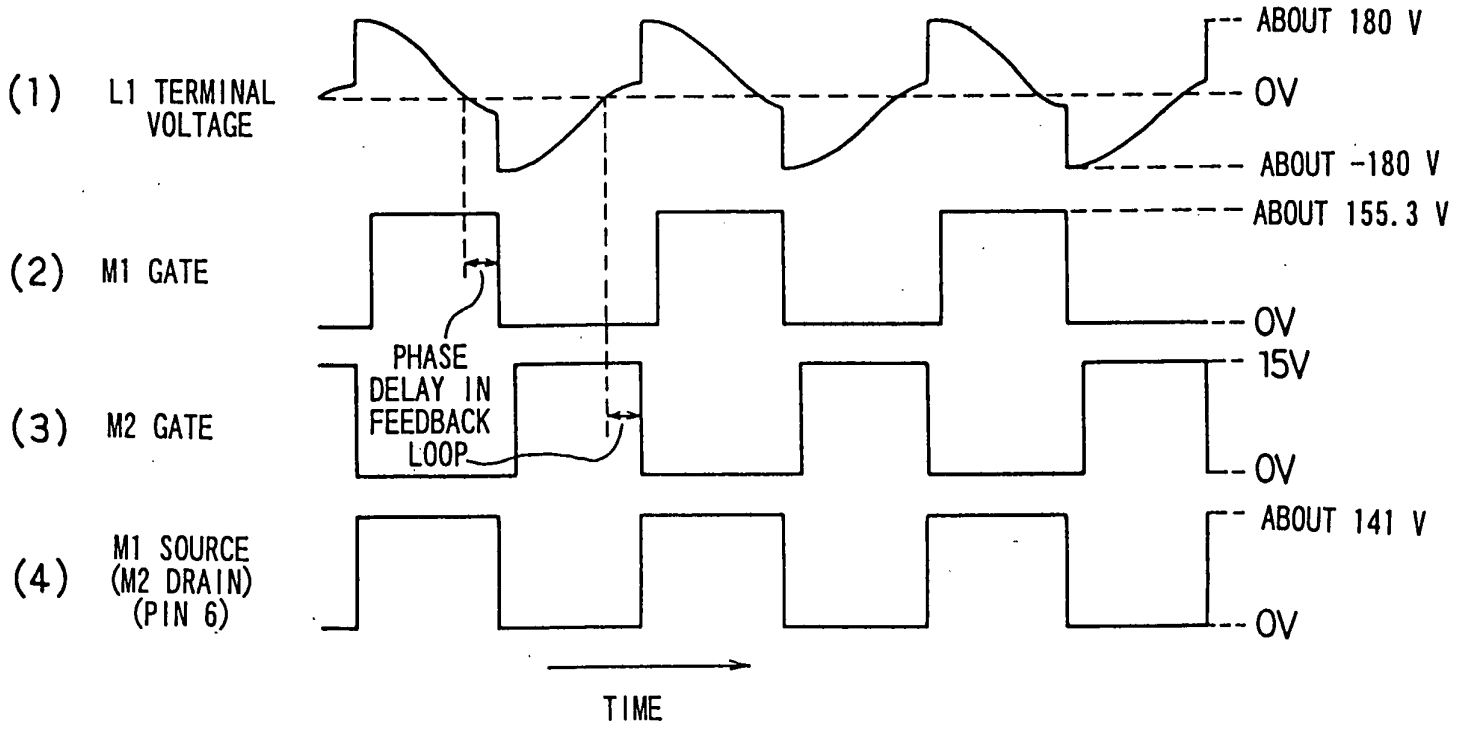

(1) L1 TERMINAL VOLTAGE
ABOUT 180 V
0V
ABOUT -180 V
(2) M1 GATE
ABOUT 155.3 V
0V
PHASE DELAY IN FEEDBACK LOOP
(3) M2 GATE
15V
0V
(4) M1 SOURCE (M2 DRAIN) (PIN 6)
ABOUT 141 V
0V
TIME

FIG. 8

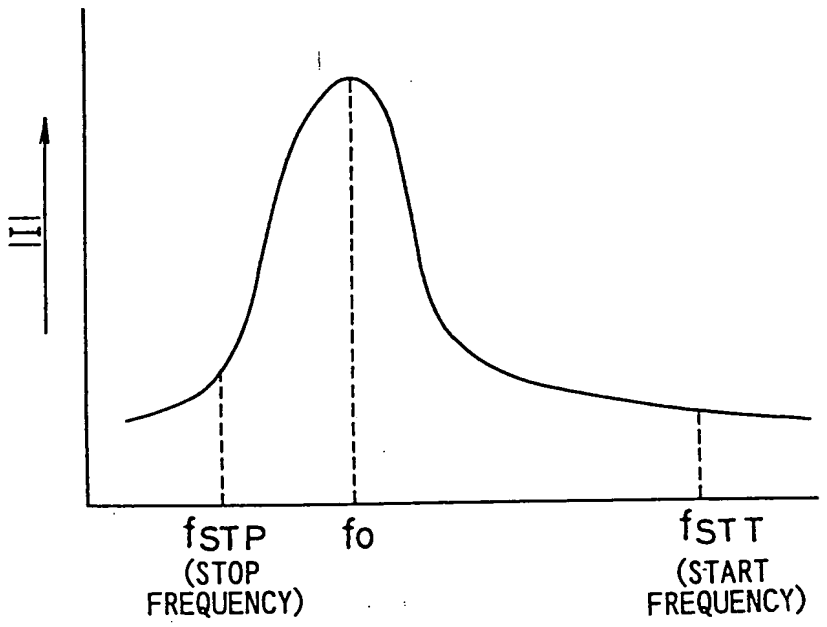


FIG. 9

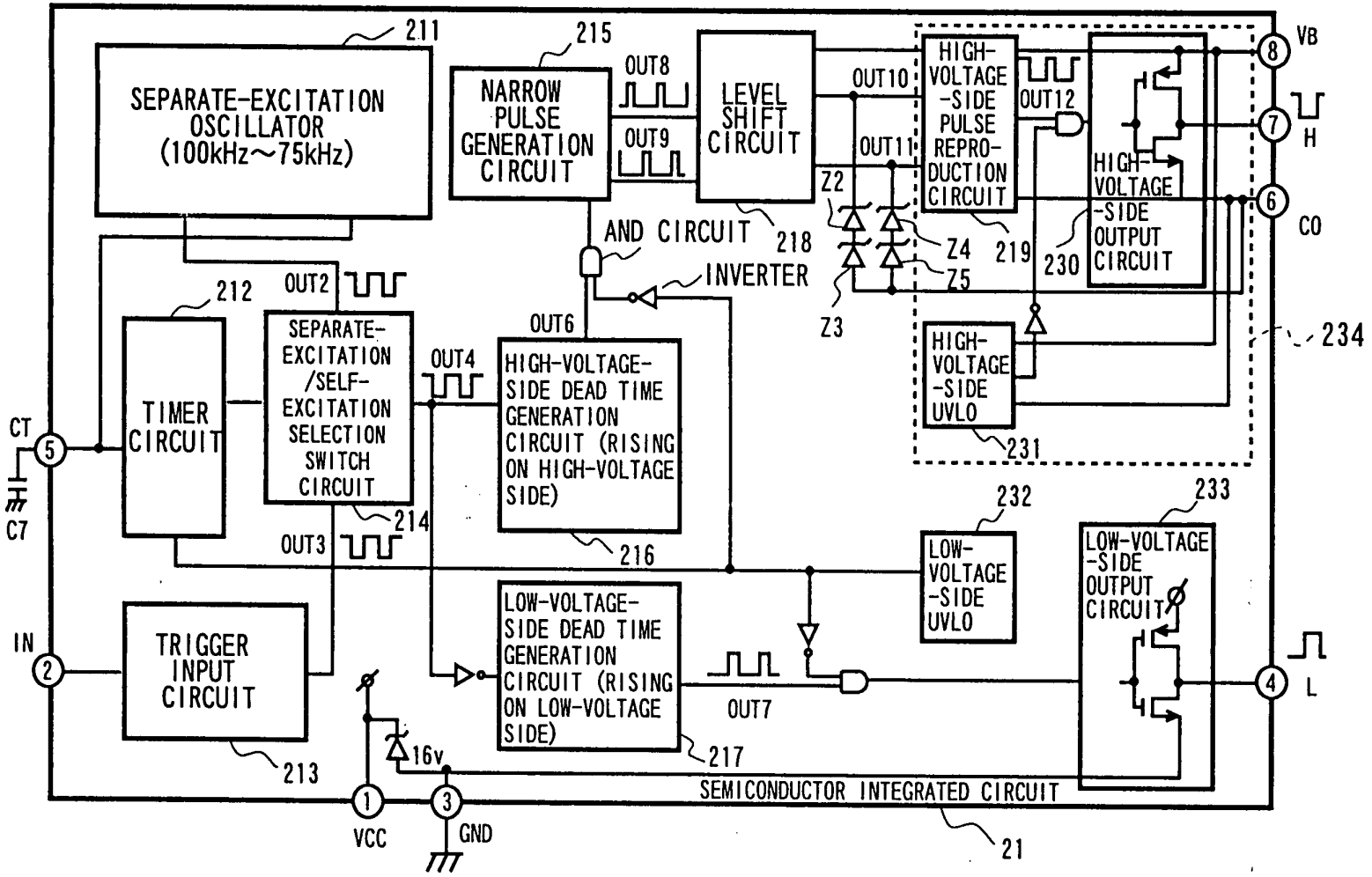

211
SEPARATE-EXCITATION OSCILLATOR (100kHz～75kHz)
215
NARROW PULSE GENERATION CIRCUIT
OUT8
OUT9
LEVEL SHIFT CIRCUIT
OUT10
OUT11
HIGH-VOLTAGE-SIDE PULSE REPRO-DUCTION CIRCUIT
OUT12
HIGH-VOLTAGE-SIDE OUTPUT CIRCUIT
VB
H
CO
Z2
Z3
Z4
Z5
219
230
AND CIRCUIT
218
INVERTER
212
OUT2
TIMER CIRCUIT
SEPARATE-EXCITATION /SELF-EXCITATION SELECTION SWITCH CIRCUIT
214
OUT4
OUT6
HIGH-VOLTAGE-SIDE DEAD TIME GENERATION CIRCUIT (RISING ON HIGH-VOLTAGE SIDE)
216
HIGH-VOLTAGE-SIDE UVLO
231
234
CT
C7
OUT3
232
LOW-VOLTAGE-SIDE UVLO
233
LOW-VOLTAGE-SIDE OUTPUT CIRCUIT
L
IN
TRIGGER INPUT CIRCUIT
213
LOW-VOLTAGE-SIDE DEAD TIME GENERATION CIRCUIT (RISING ON LOW-VOLTAGE SIDE)
217
OUT7
16v
SEMICONDUCTOR INTEGRATED CIRCUIT
21
VCC
GND

FIG. 10

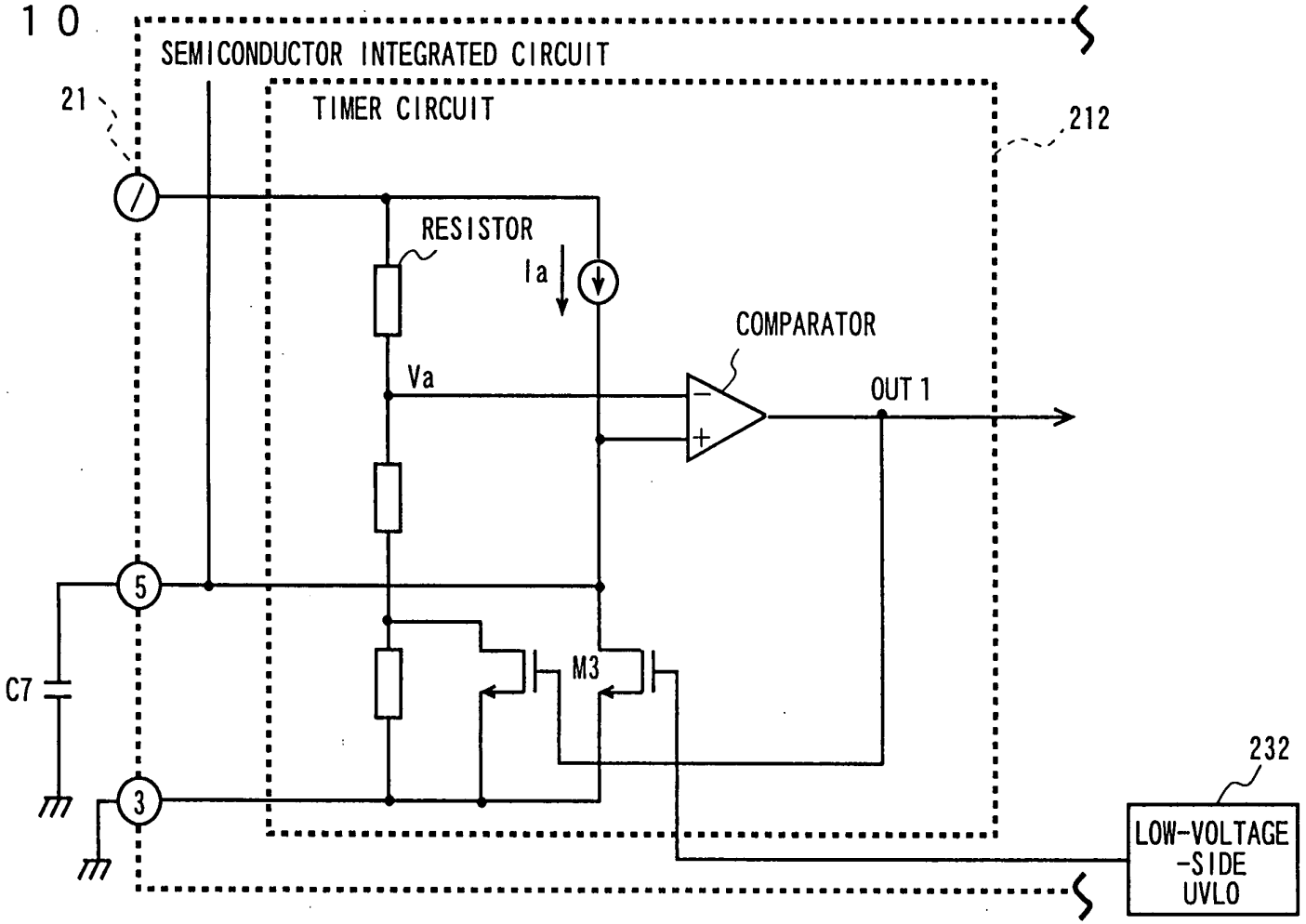

SEMICONDUCTOR INTEGRATED CIRCUIT
21
TIMER CIRCUIT
212
RESISTOR
Ia
COMPARATOR
Va
OUT 1
5
C7
M3
3
232
LOW-VOLTAGE
-SIDE
UVLO

FIG. 11

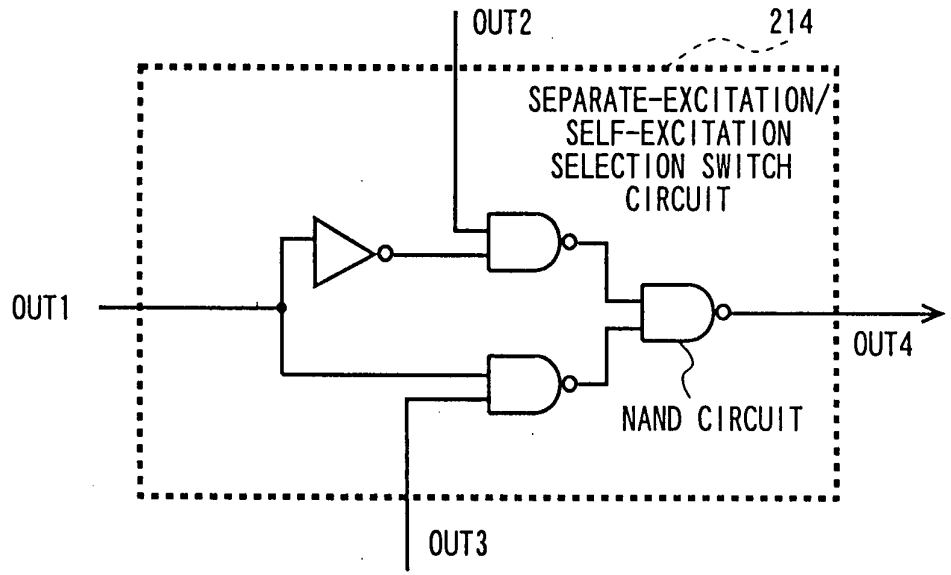

OUT2
214
SEPARATE-EXCITATION/
SELF-EXCITATION
SELECTION SWITCH
CIRCUIT
OUT1
OUT4
NAND CIRCUIT
OUT3

FIG. 12

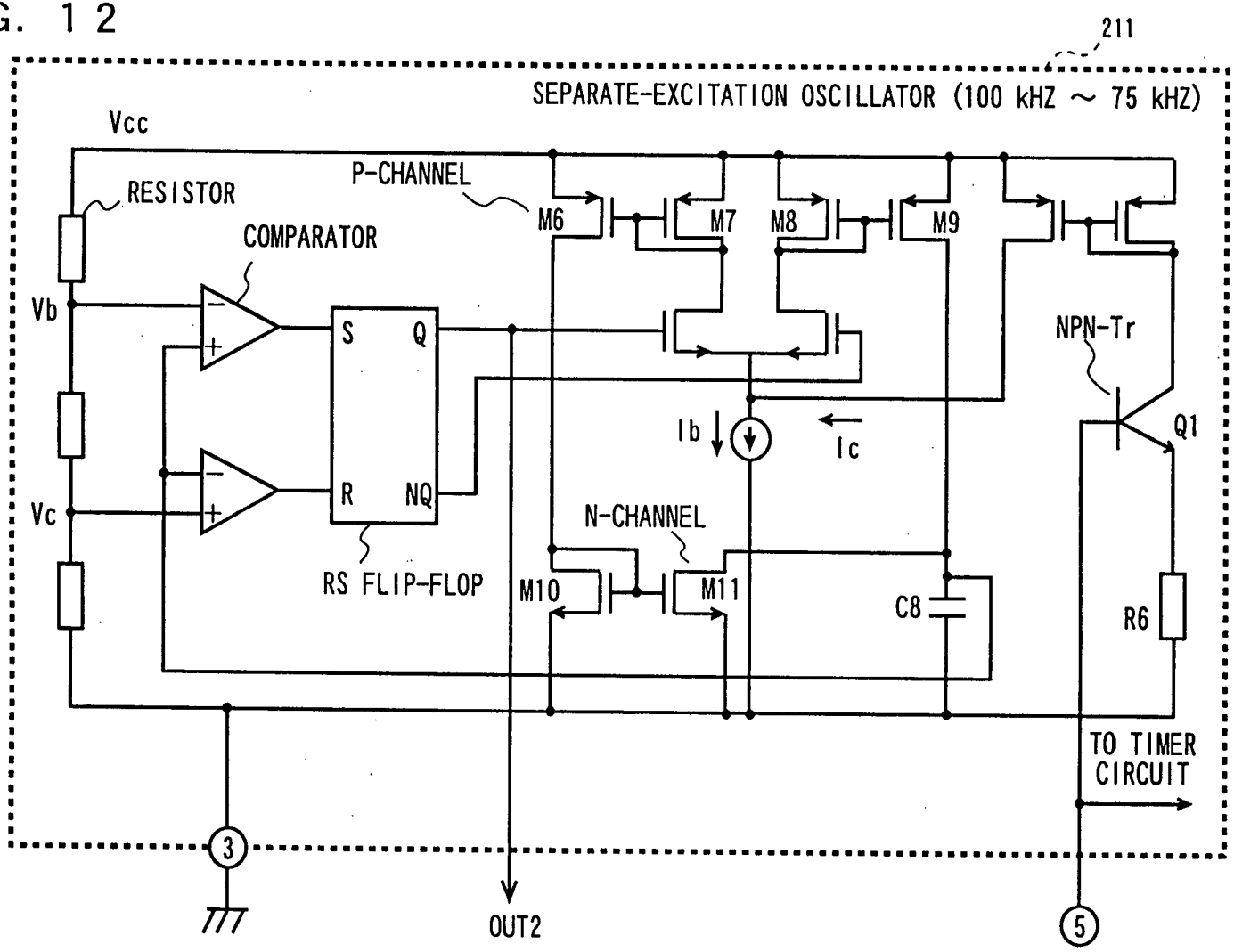

211
SEPARATE-EXCITATION OSCILLATOR (100 kHZ ~ 75 kHZ)
Vcc
RESISTOR
P-CHANNEL
M6
M7
M8
M9
COMPARATOR
Vb
Vc
S
Q
R
NQ
RS FLIP-FLOP
Ib
Ic
NPN-Tr
Q1
N-CHANNEL
M10
M11
C8
R6
TO TIMER CIRCUIT
3
OUT2
5

FIG. 13

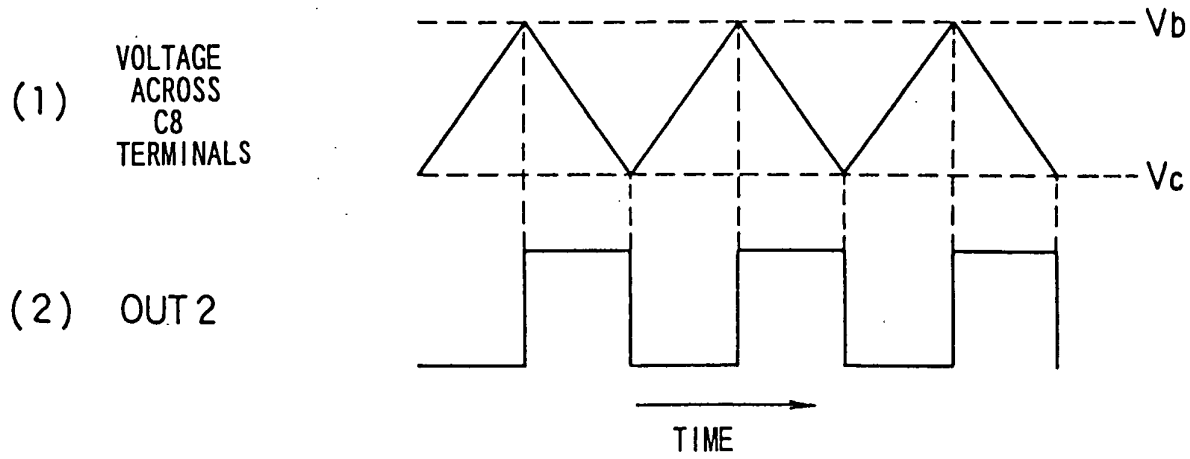


FIG. 14

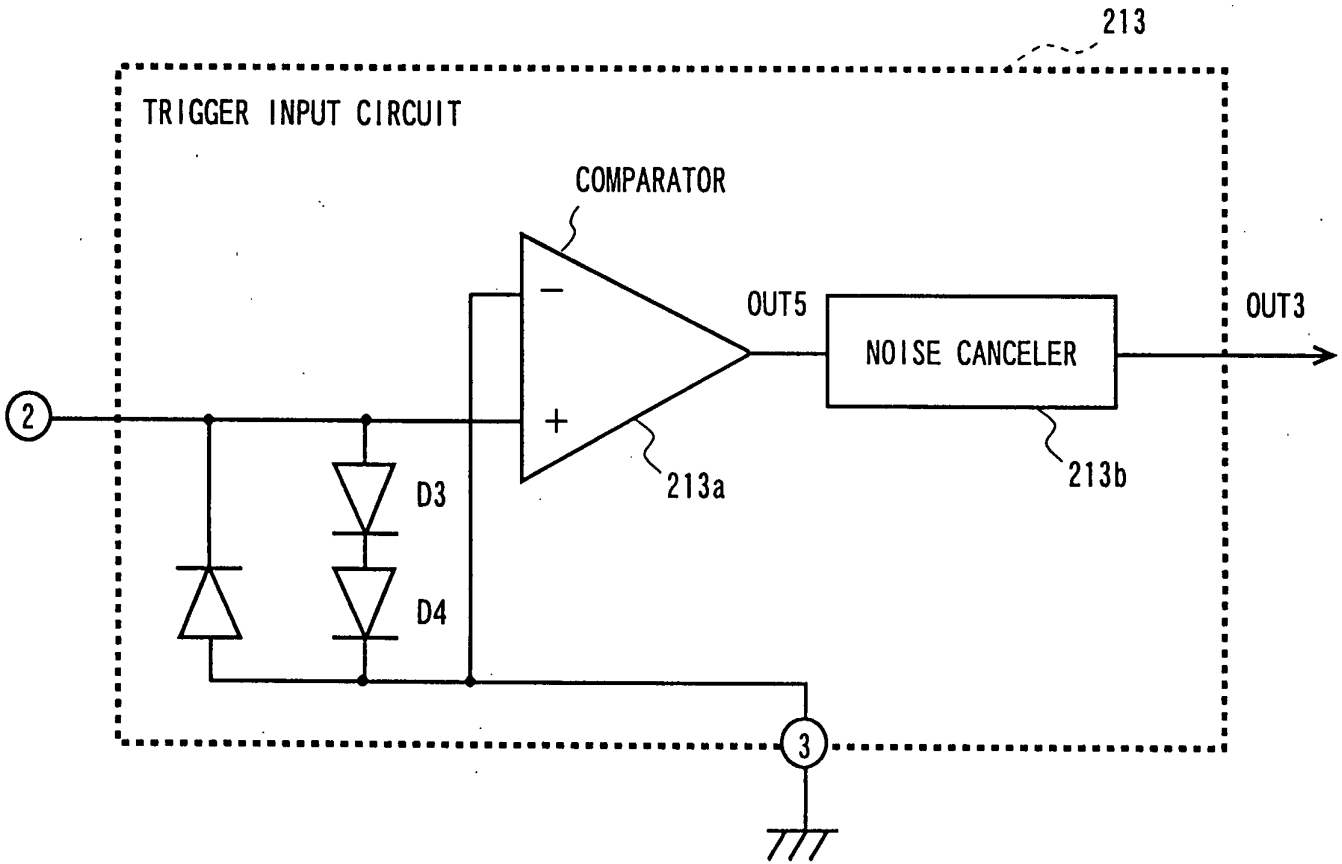

213
TRIGGER INPUT CIRCUIT
COMPARATOR
OUT5
NOISE CANCELER
OUT3
2
D3
D4
213a
213b
3

FIG. 15

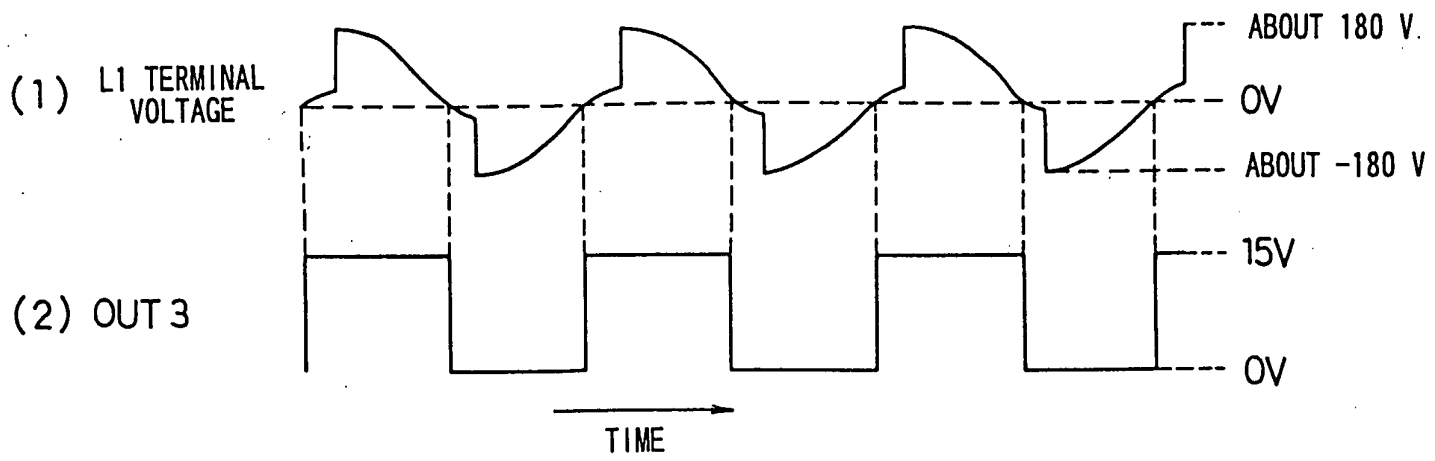

(1) L1 TERMINAL VOLTAGE
(2) OUT 3
ABOUT 180 V.
0V
ABOUT -180 V
15V
0V
TIME

FIG. 16

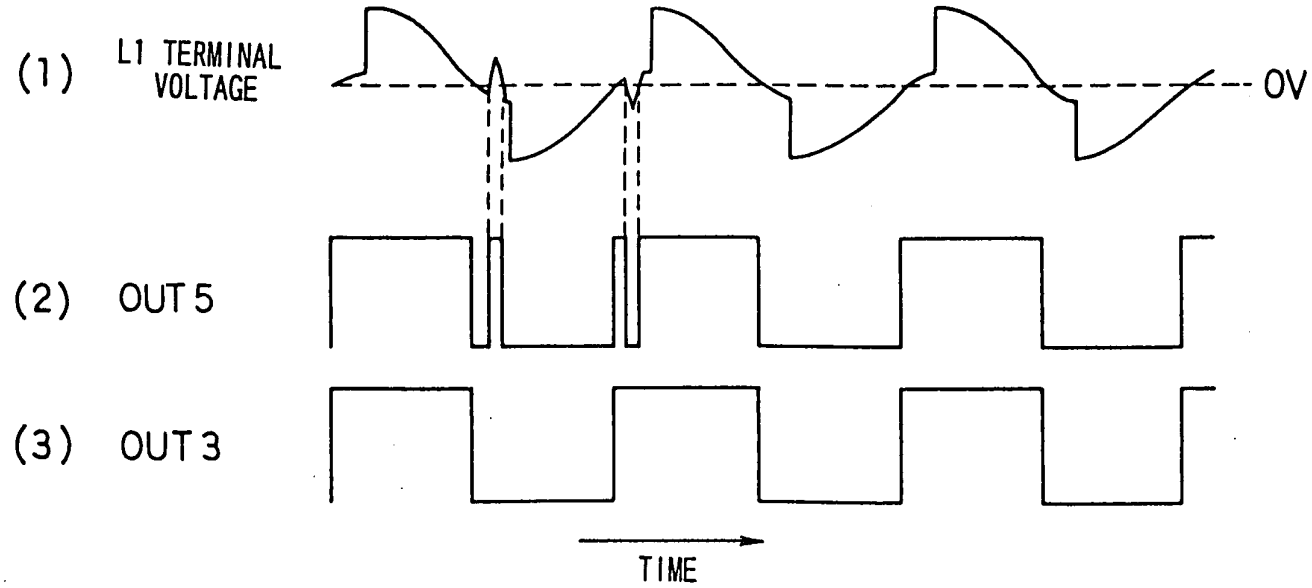


FIG. 17

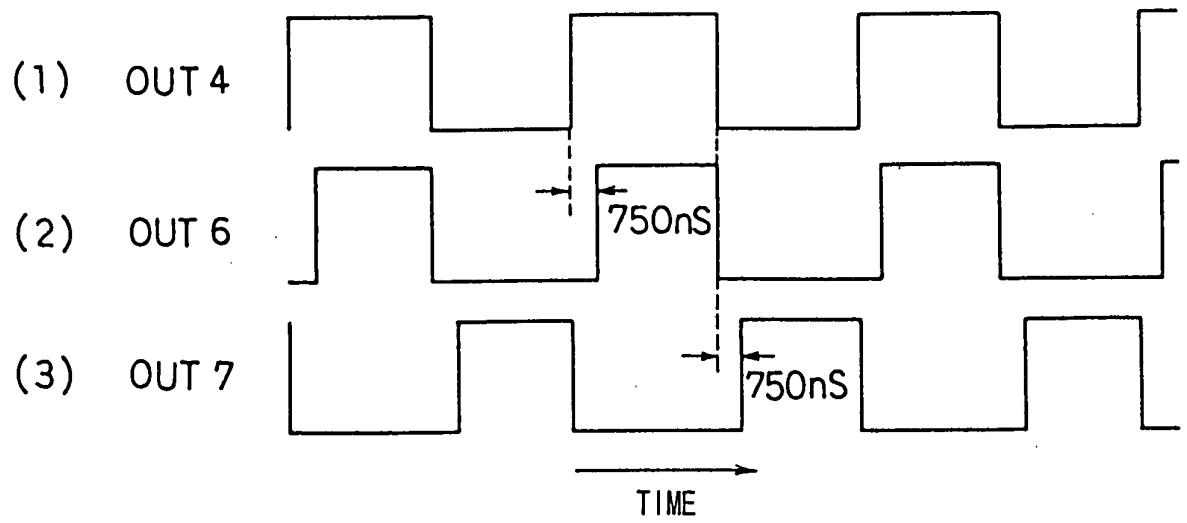


FIG. 18

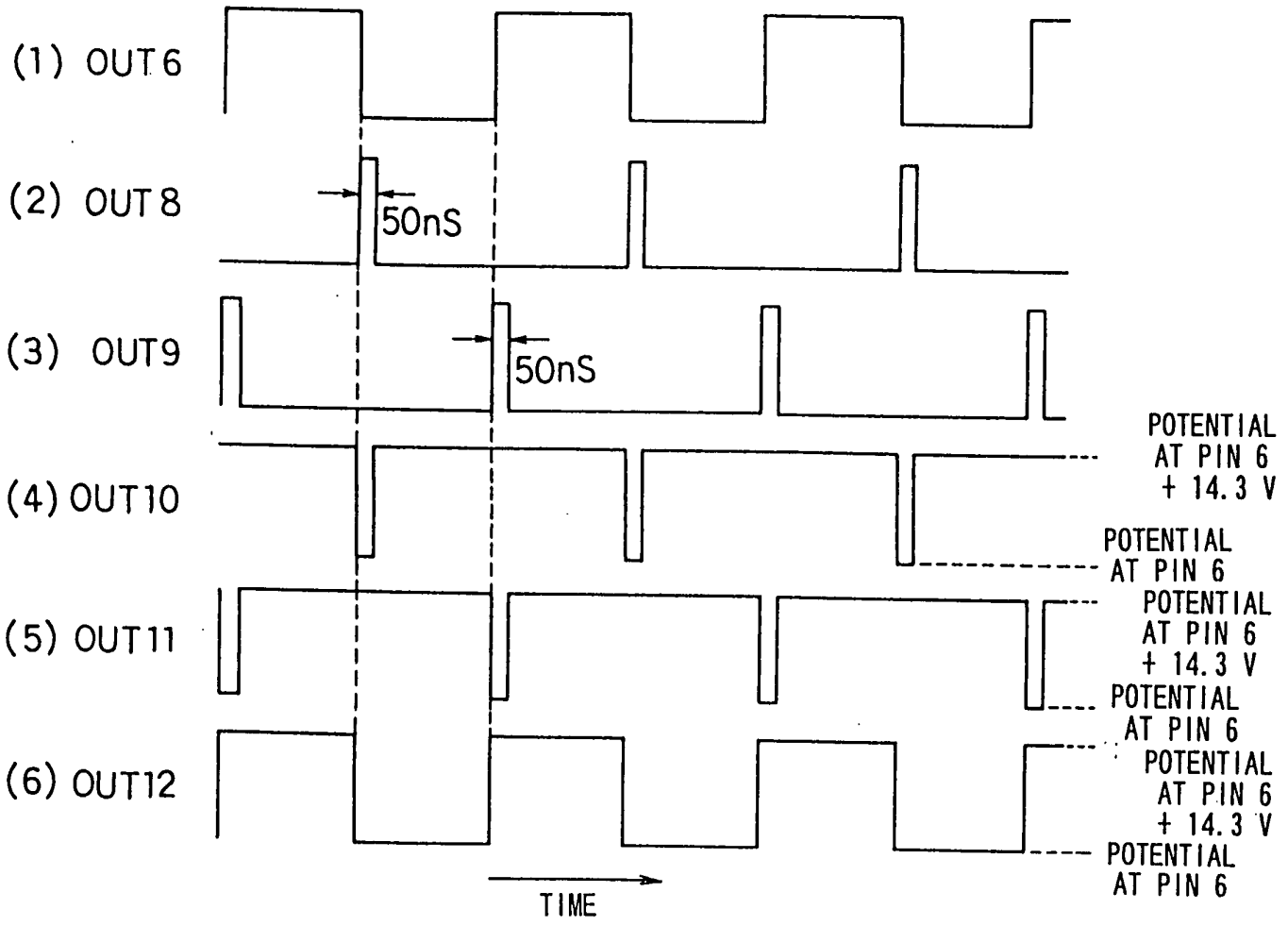

(1) OUT6
(2) OUT8
50nS
(3) OUT9
50nS
(4) OUT10
(5) OUT11
(6) OUT12
TIME
POTENTIAL AT PIN 6 + 14.3 V
POTENTIAL AT PIN 6
POTENTIAL AT PIN 6 + 14.3 V
POTENTIAL AT PIN 6
POTENTIAL AT PIN 6 + 14.3 V
POTENTIAL AT PIN 6

FIG. 19

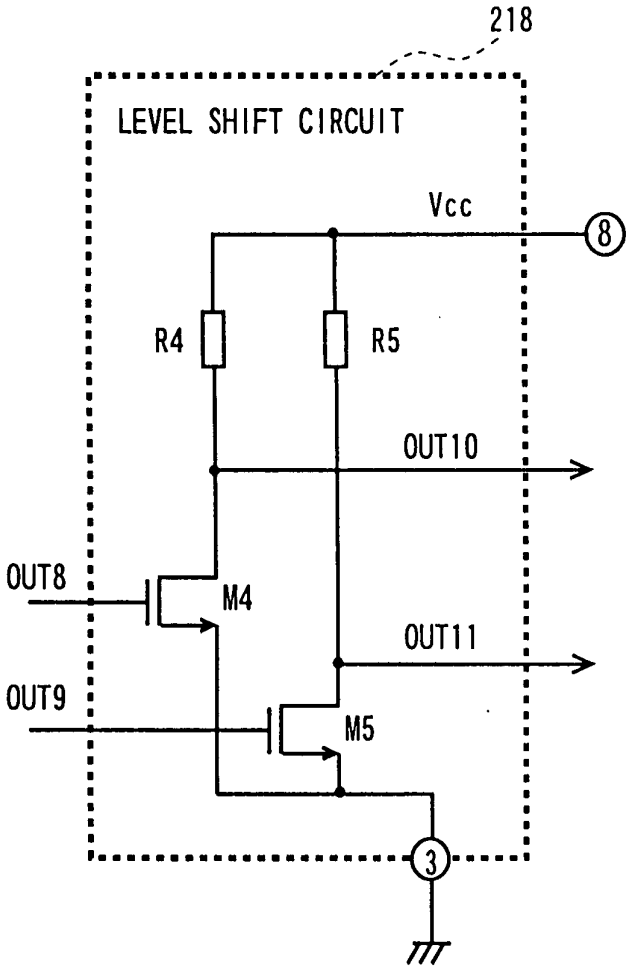

218
LEVEL SHIFT CIRCUIT
Vcc
8
R4
R5
OUT10
OUT8
M4
OUT11
OUT9
M5
3

FIG. 20

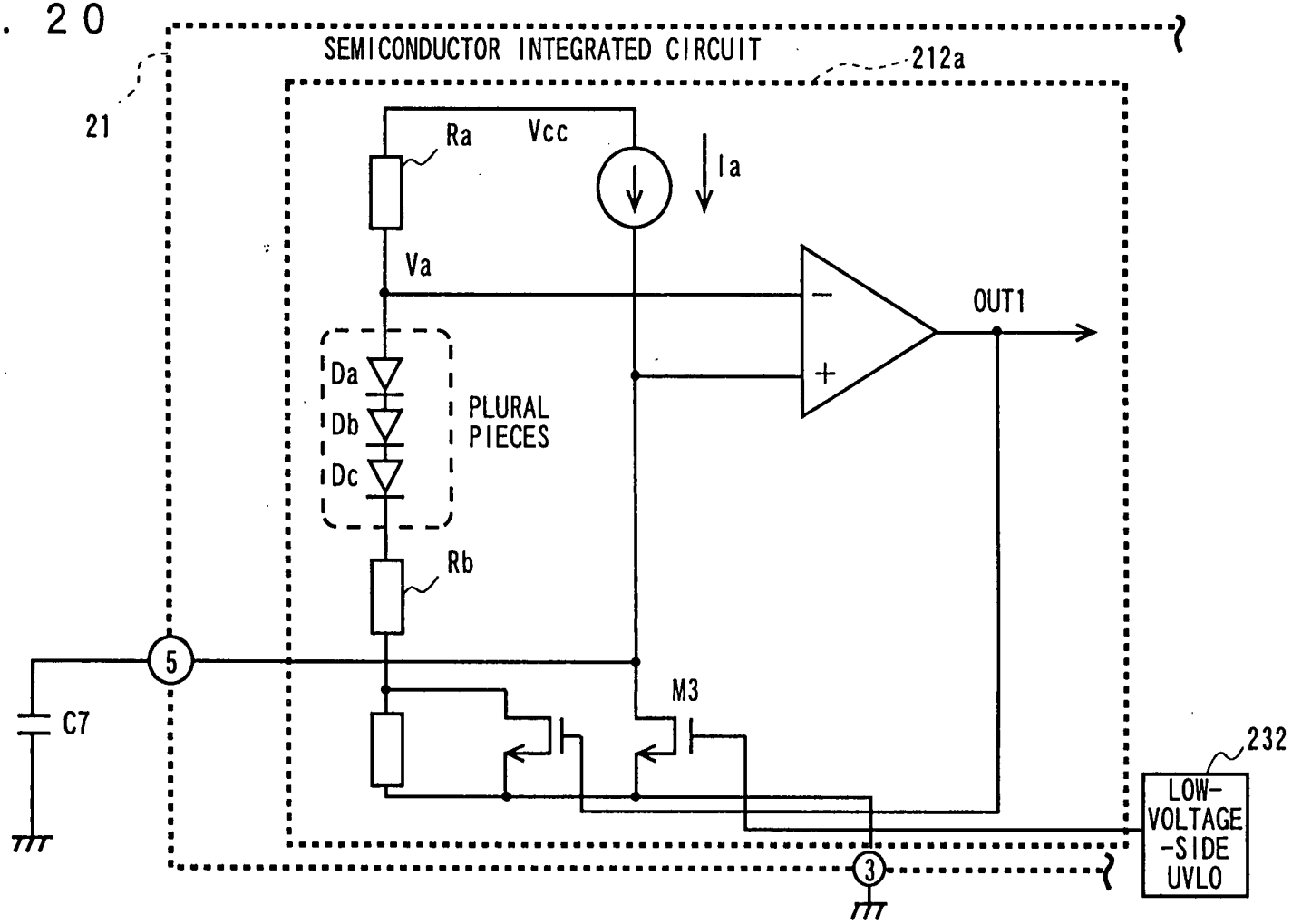
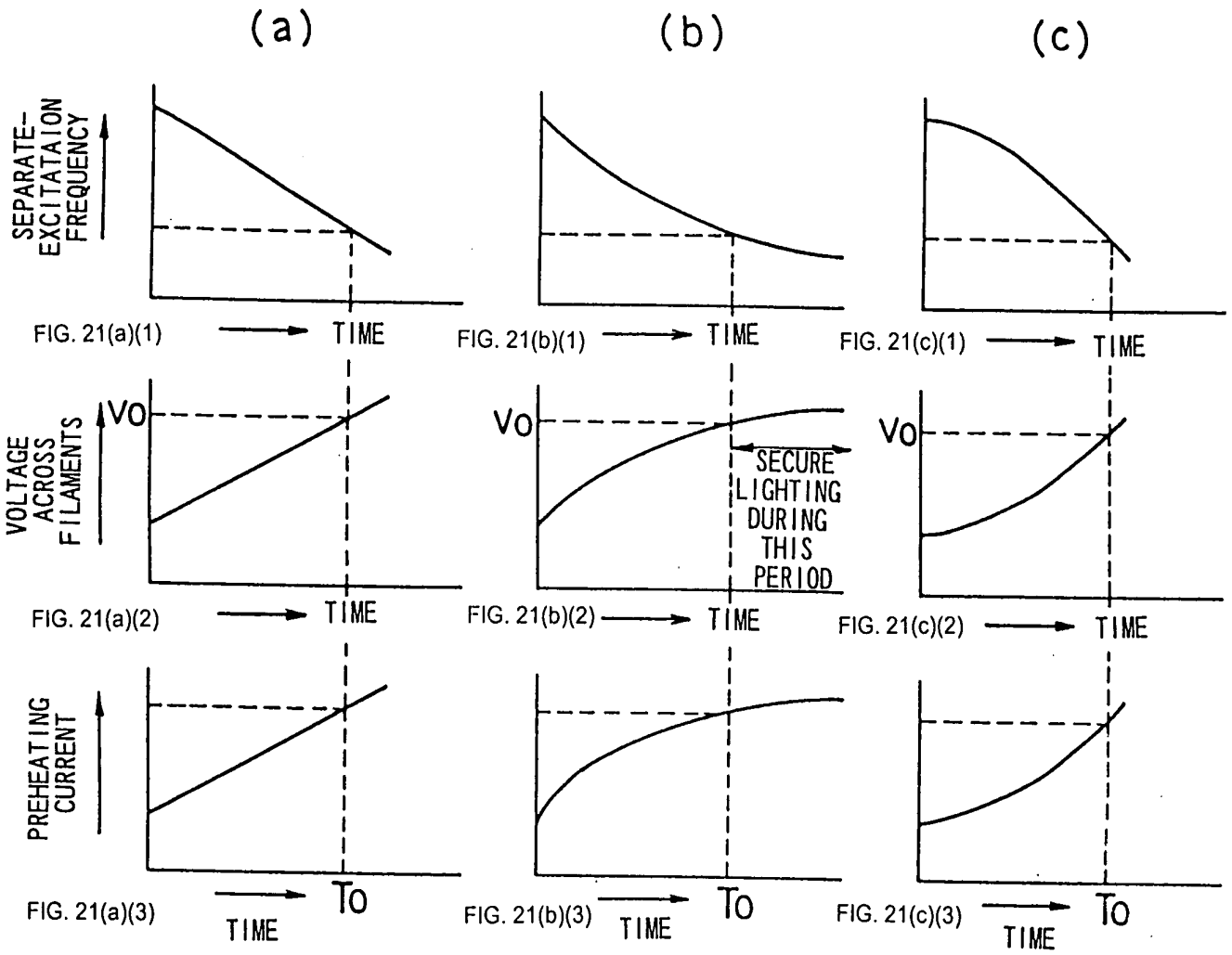

SEMICONDUCTOR INTEGRATED CIRCUIT
21
212a
Ra
Vcc
Ia
Va
OUT1
Da
Db
Dc
PLURAL PIECES
Rb
5
C7
M3
232
LOW-VOLTAGE-SIDE UVLO
3

FIG. 21



* To - TIME UNTIL LIGHTING
Vo - LIGHTING VOLTAGE

FIG. 22

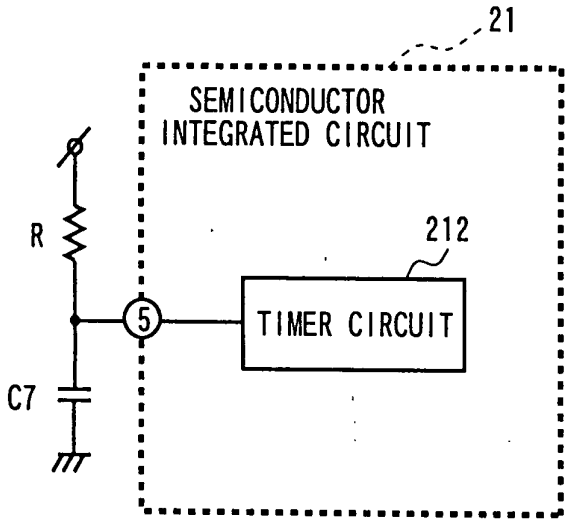


FIG. 22(a)

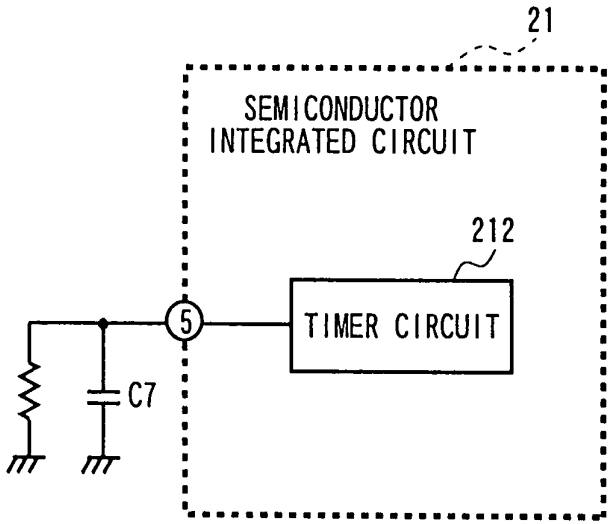


FIG. 22(b)

FIG. 23

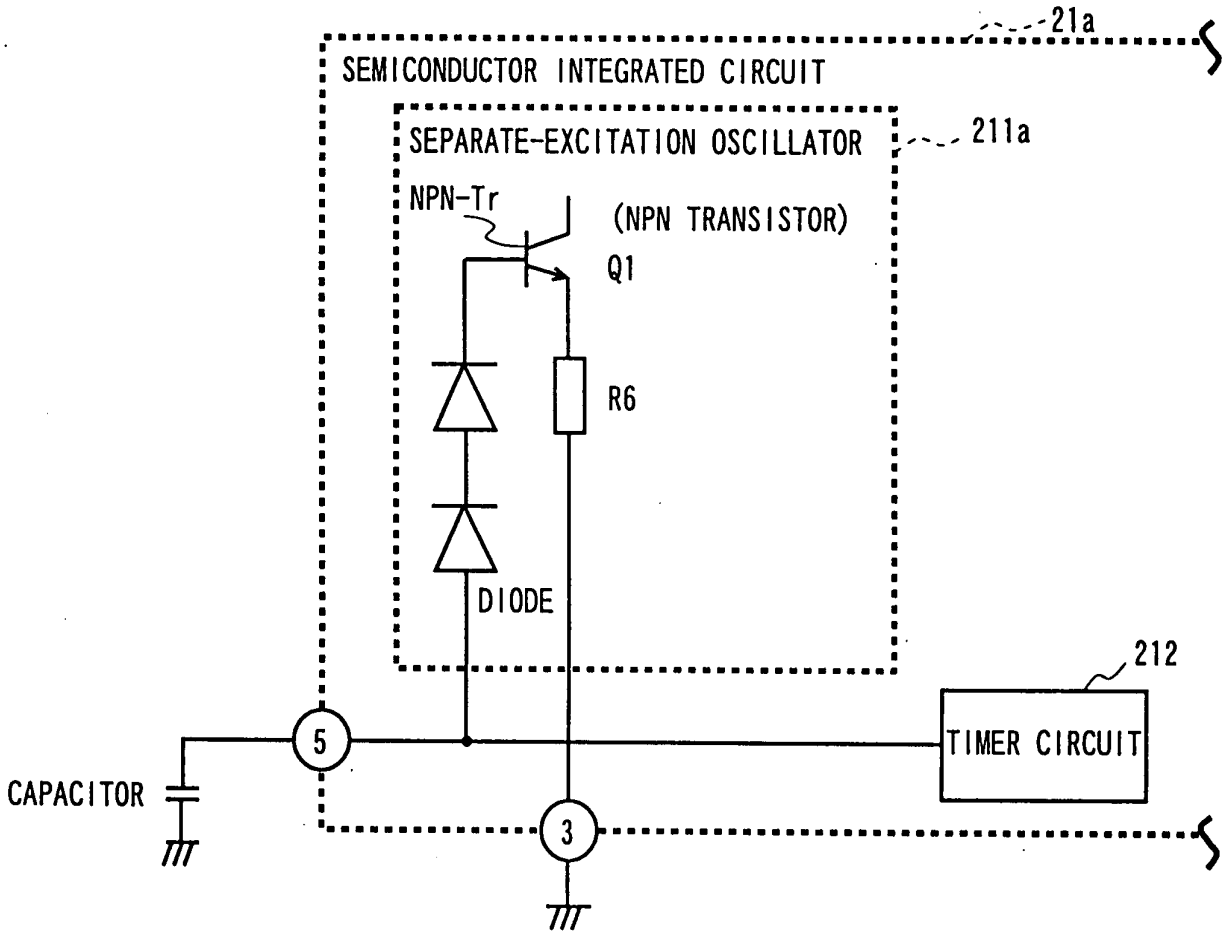

21a
SEMICONDUCTOR INTEGRATED CIRCUIT
SEPARATE-EXCITATION OSCILLATOR
211a
NPN-Tr
(NPN TRANSISTOR)
Q1
R6
DIODE
212
TIMER CIRCUIT
5
3
CAPACITOR

FIG. 24

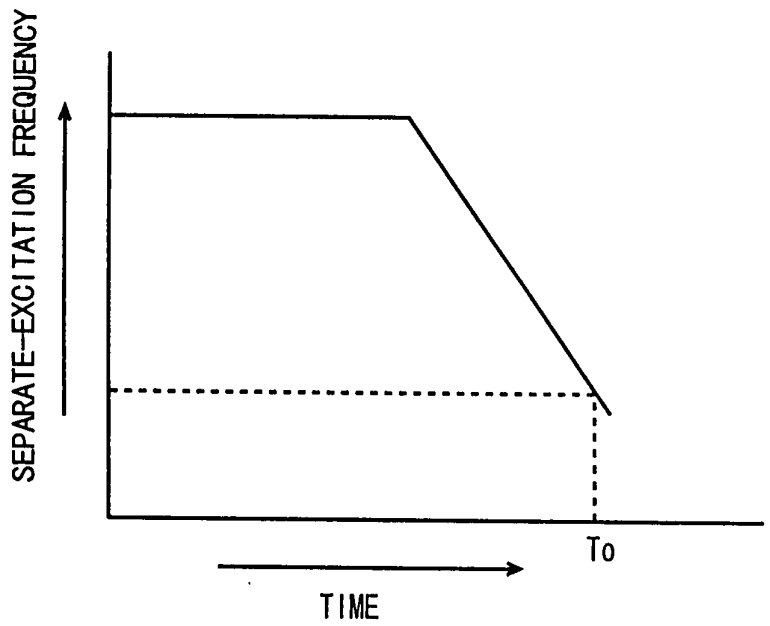


FIG. 25

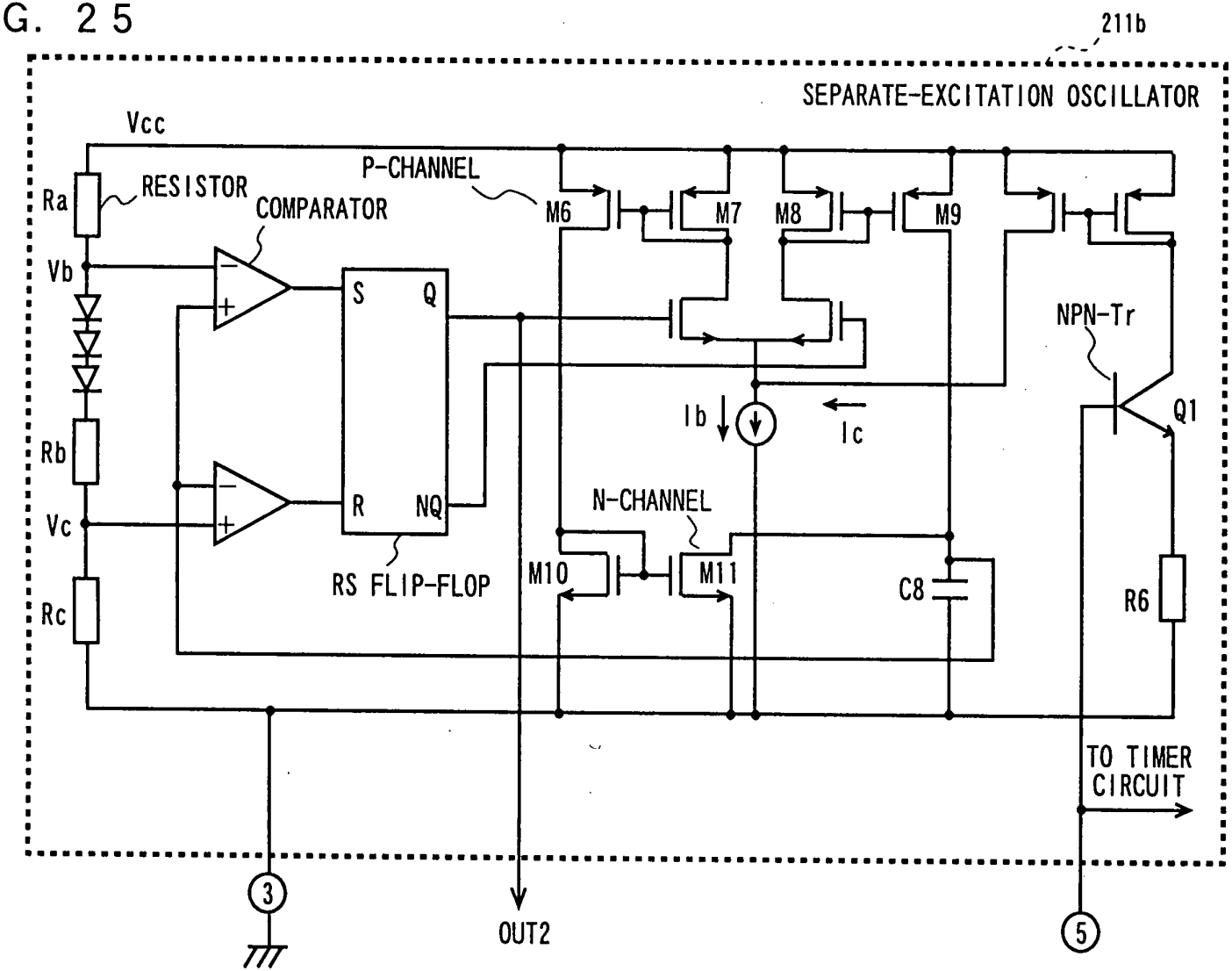
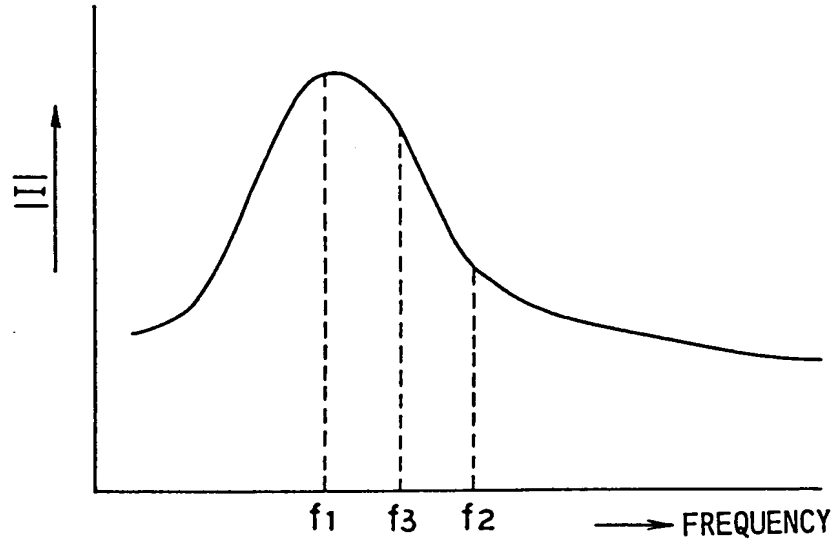
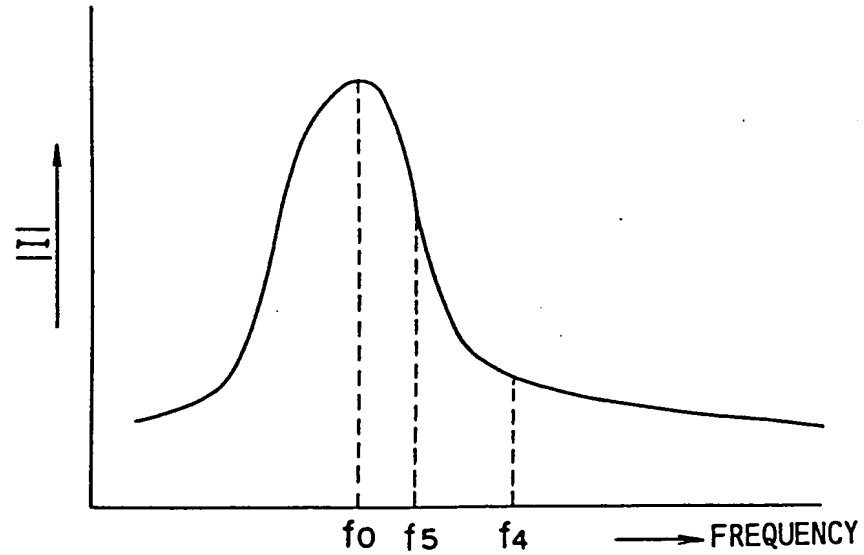

211b
SEPARATE-EXCITATION OSCILLATOR
Vcc
Ra
RESISTOR
COMPARATOR
P-CHANNEL
M6
M7
M8
M9
Vb
S
Q
NPN-Tr
Q1
Ib
Ic
Rb
Vc
R
NQ
N-CHANNEL
M10
M11
C8
R6
RS FLIP-FLOP
Rc
TO TIMER CIRCUIT
3
OUT2
5

FIG. 26



FREQUENCY CHARACTERISTIC
AT LIGHTING

FIG. 27



FREQUENCY CHARACTERISTIC
BEFORE LIGHTING

FIG. 28

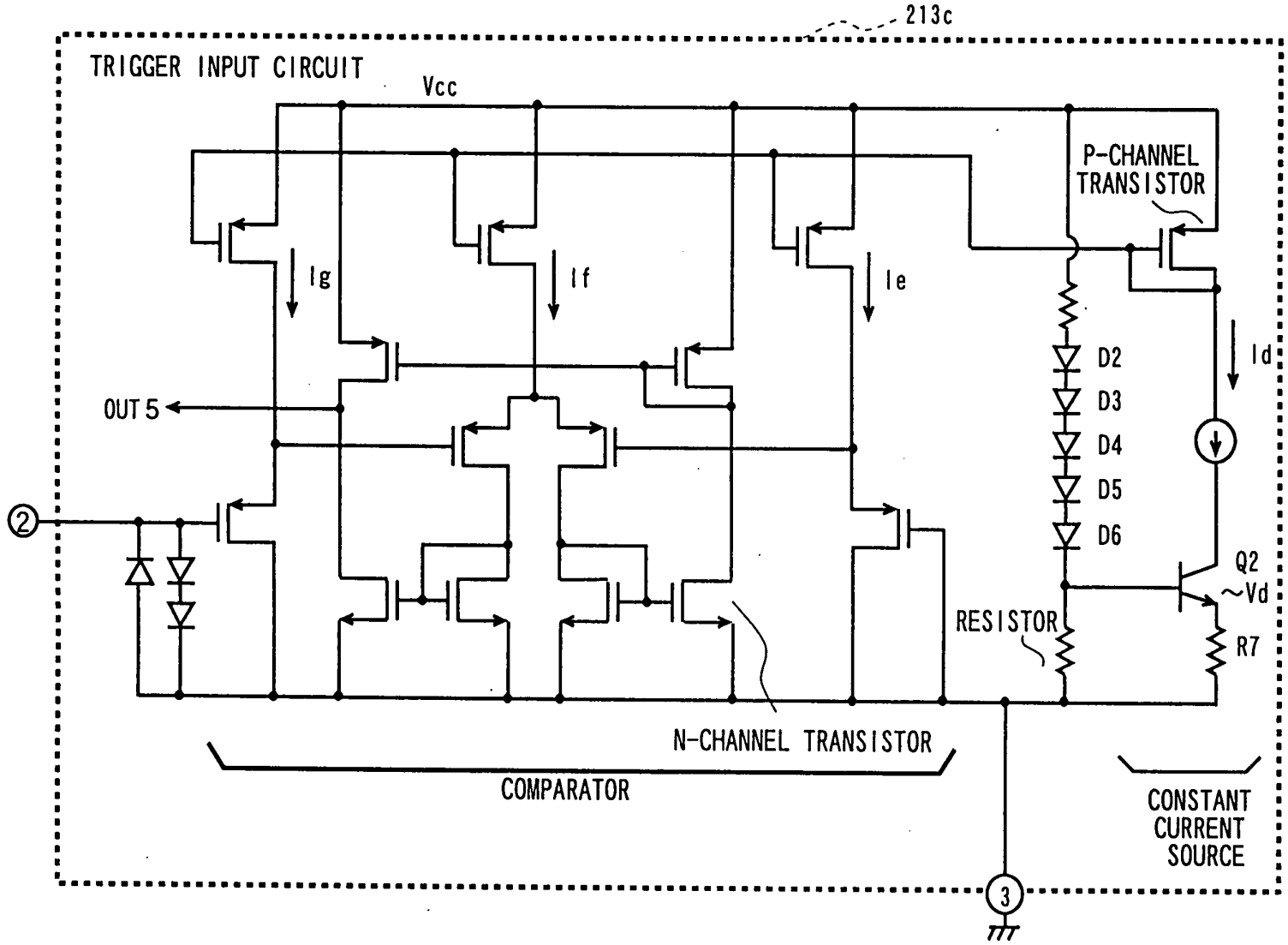

213c
TRIGGER INPUT CIRCUIT
Vcc
P-CHANNEL TRANSISTOR
Ig
If
Ie
Id
D2
D3
D4
D5
D6
OUT5
②
Q2
~Vd
RESISTOR
R7
N-CHANNEL TRANSISTOR
COMPARATOR
CONSTANT CURRENT SOURCE
3

FIG. 29

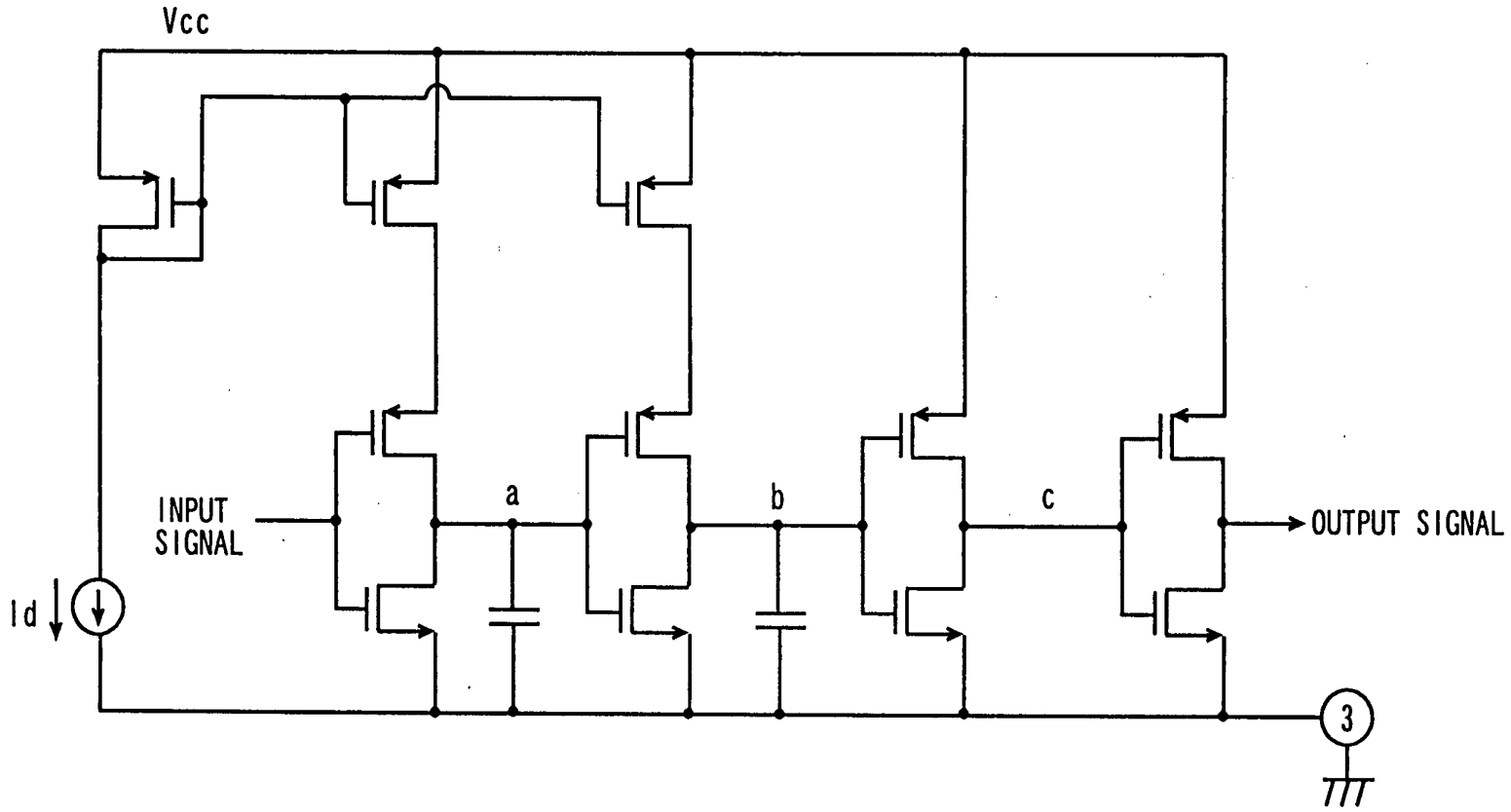


FIG. 30

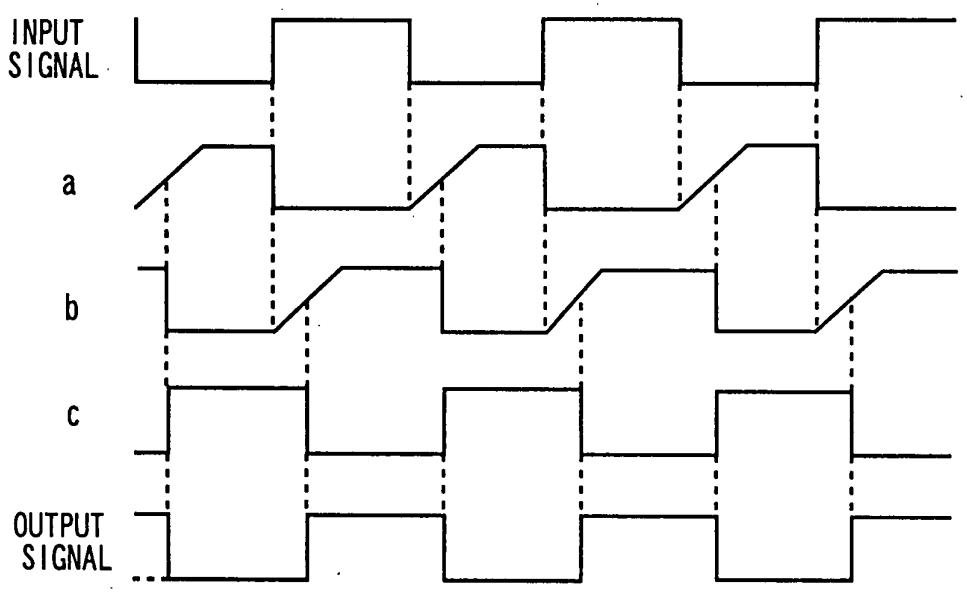
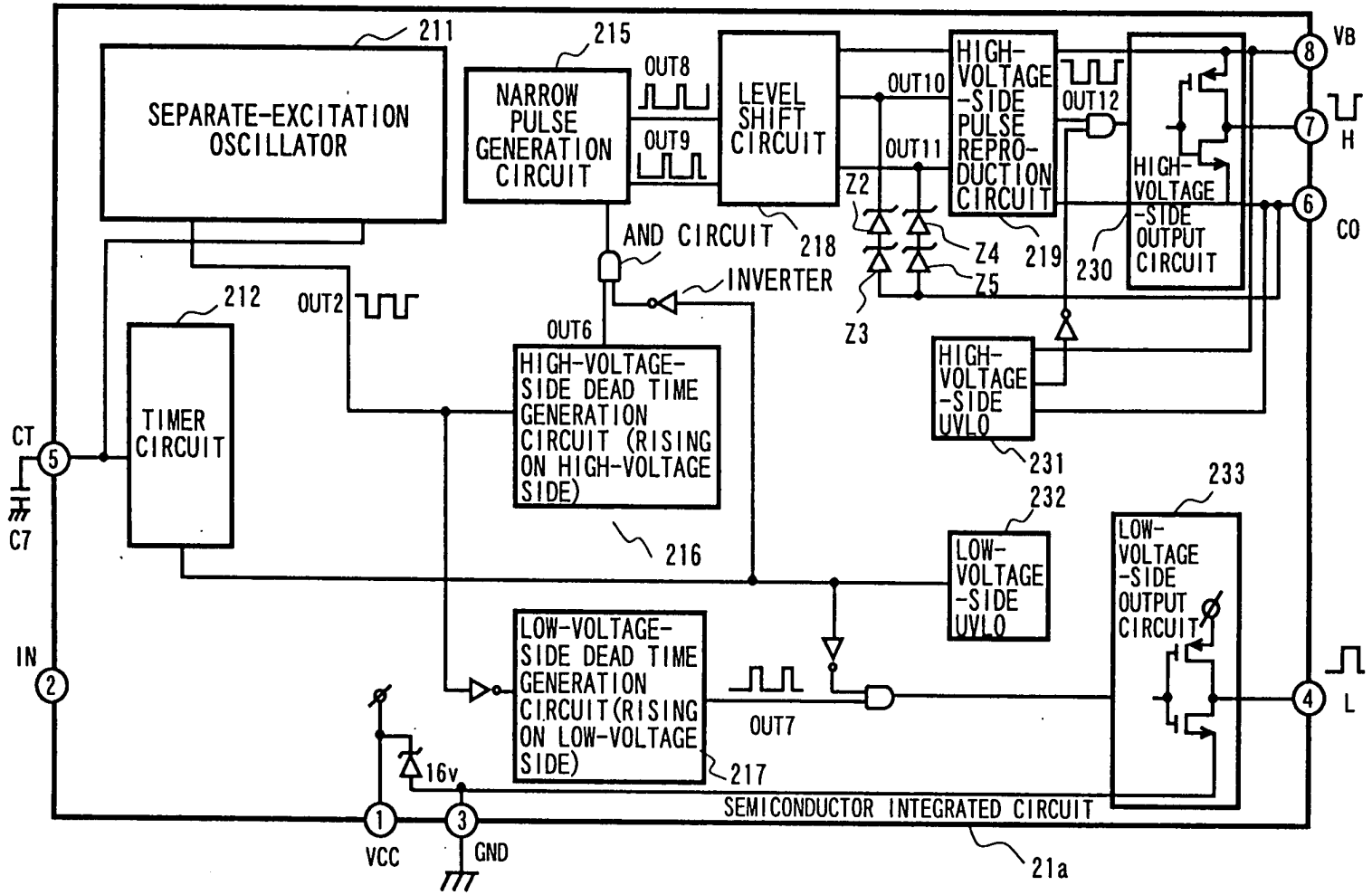


FIG. 31


211
SEPARATE-EXCITATION OSCILLATOR
215
NARROW PULSE GENERATION CIRCUIT
OUT8
OUT9
LEVEL SHIFT CIRCUIT
OUT10
OUT11
HIGH-VOLTAGE-SIDE PULSE REPRO-DUCTION CIRCUIT
OUT12
HIGH-VOLTAGE-SIDE OUTPUT CIRCUIT
VB
H
CO
Z2
Z4
Z5
Z3
219
230
AND CIRCUIT
218
INVERTER
212
OUT2
OUT6
TIMER CIRCUIT
HIGH-VOLTAGE-SIDE DEAD TIME GENERATION CIRCUIT (RISING ON HIGH-VOLTAGE SIDE)
HIGH-VOLTAGE-SIDE UVLO
231
233
232
LOW-VOLTAGE-SIDE UVLO
LOW-VOLTAGE-SIDE OUTPUT CIRCUIT
CT
C7
IN
216
LOW-VOLTAGE-SIDE DEAD TIME GENERATION CIRCUIT(RISING ON LOW-VOLTAGE SIDE)
OUT7
16v
217
L
SEMICONDUCTOR INTEGRATED CIRCUIT
VCC
GND
21a

TIME
t1
t0
f1
f0
OUTPUT FREQUENCY OF
SEPARATE-EXCITATION
OSCILLATOR

FIG. 32

FIG. 33

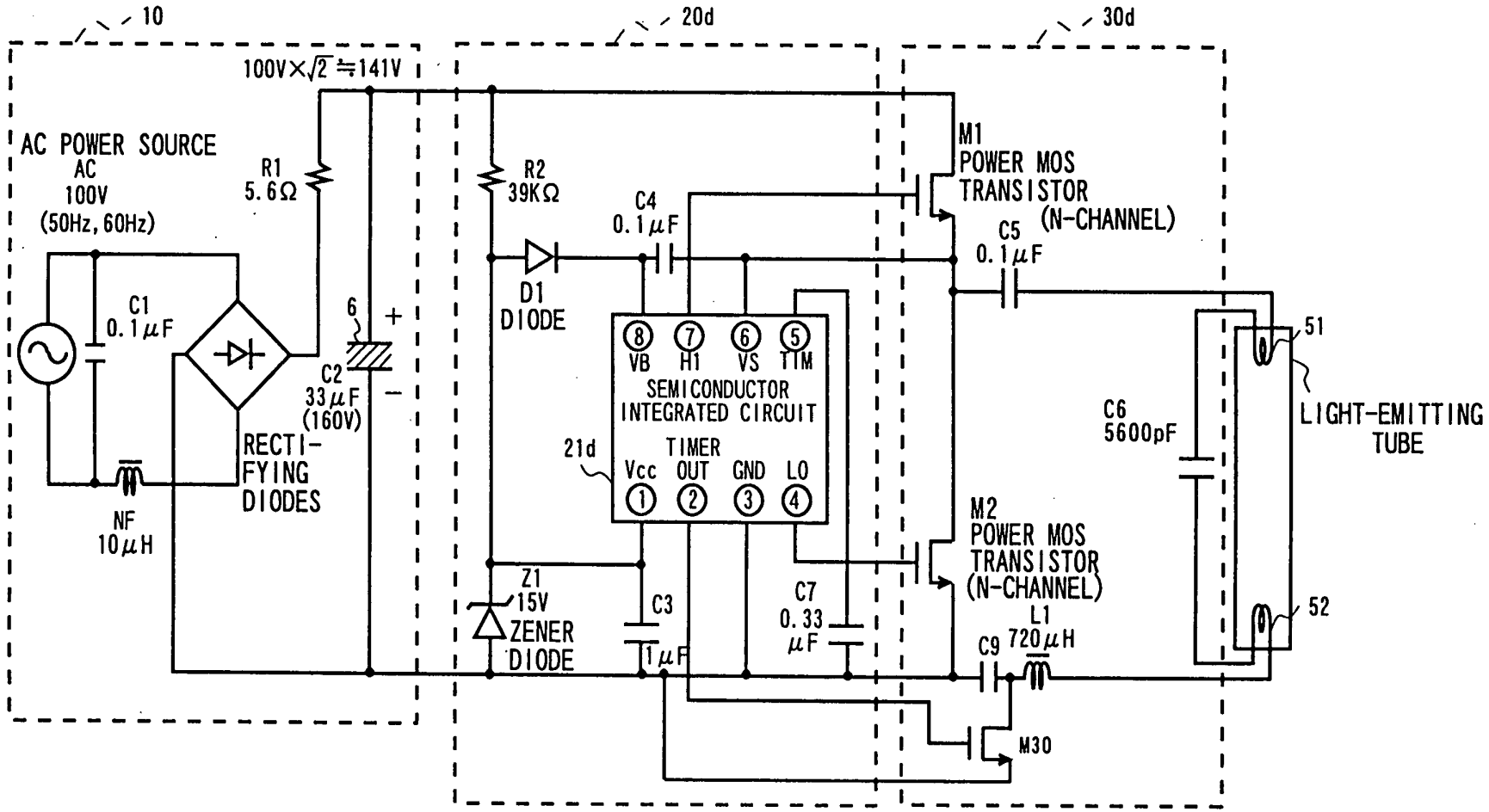
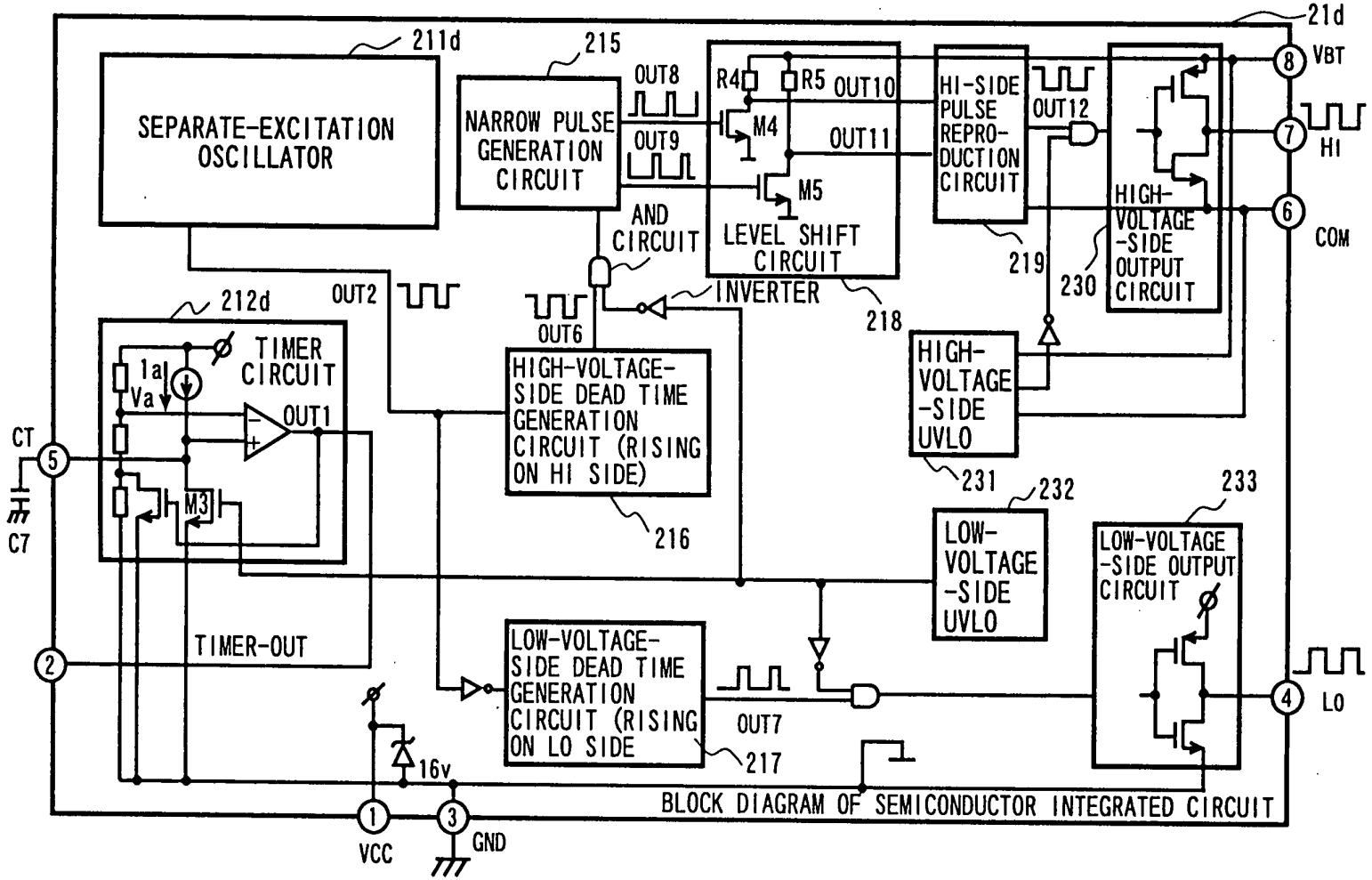

10
20d
30d
100V×√2 ≒141V
AC POWER SOURCE
AC
100V
(50Hz, 60Hz)
R1
5.6Ω
R2
39KΩ
C4
0.1μF
M1
POWER MOS
TRANSISTOR
(N-CHANNEL)
C5
0.1μF
C1
0.1μF
6
+
C2
33μF
(160V)
−
D1
DIODE
8 VB
7 H1
6 VS
5 TIM
SEMICONDUCTOR
INTEGRATED CIRCUIT
21d
TIMER
Vcc OUT GND LO
1 2 3 4
C6
5600pF
51
LIGHT-EMITTING
TUBE
RECTI-
FYING
DIODES
NF
10μH
M2
POWER MOS
TRANSISTOR
(N-CHANNEL)
Z1
15V
ZENER
DIODE
C3
1μF
C7
0.33
μF
L1
720μH
C9
52
M30

FIG. 34



BLOCK DIAGRAM OF SEMICONDUCTOR INTEGRATED CIRCUIT

FIG. 35

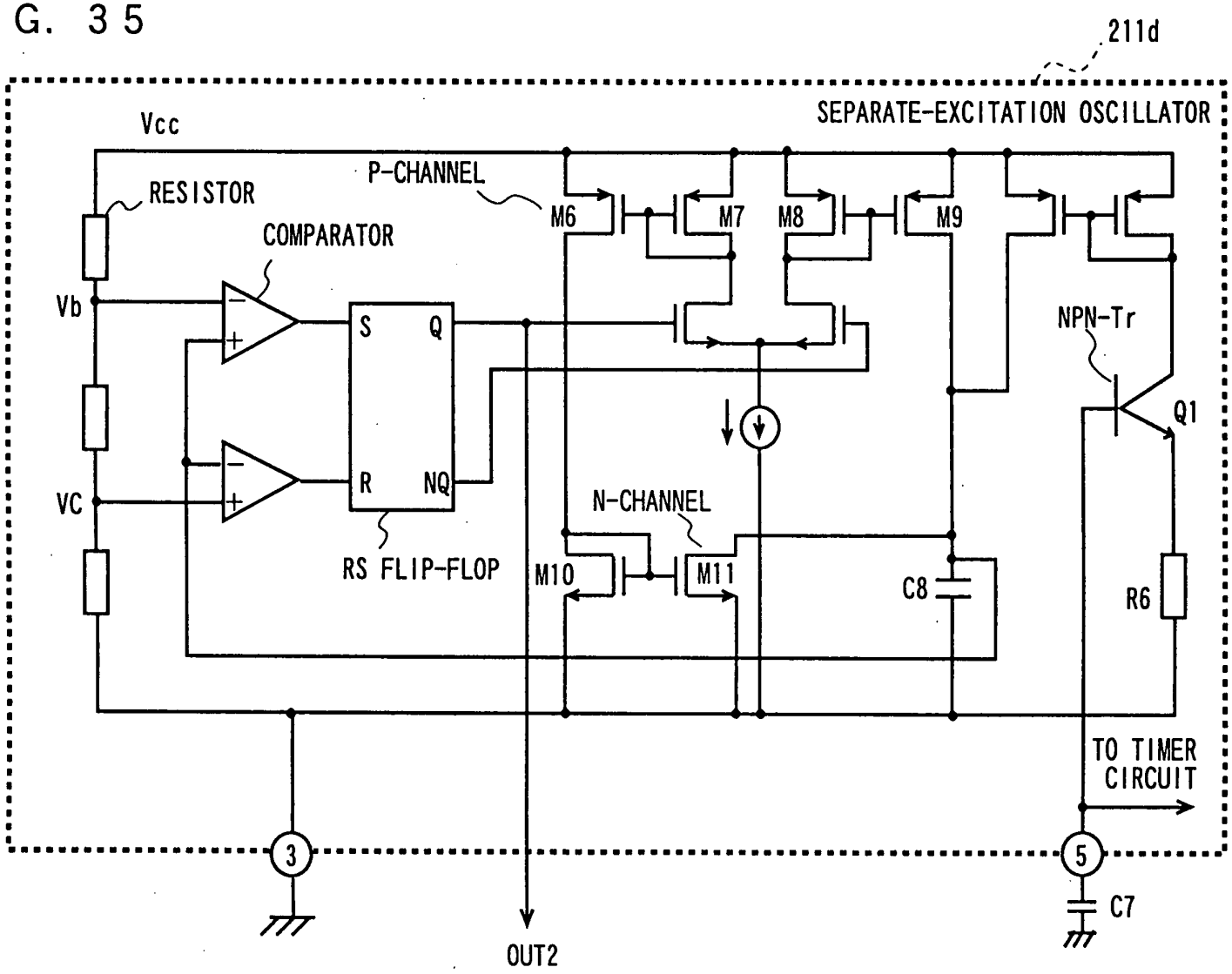

211d
SEPARATE-EXCITATION OSCILLATOR
Vcc
RESISTOR
P-CHANNEL
M6
M7
M8
M9
COMPARATOR
Vb
S
Q
NPN-Tr
Q1
VC
R
NQ
N-CHANNEL
RS FLIP-FLOP
M10
M11
C8
R6
TO TIMER CIRCUIT
3
5
C7
OUT2

FIG. 36

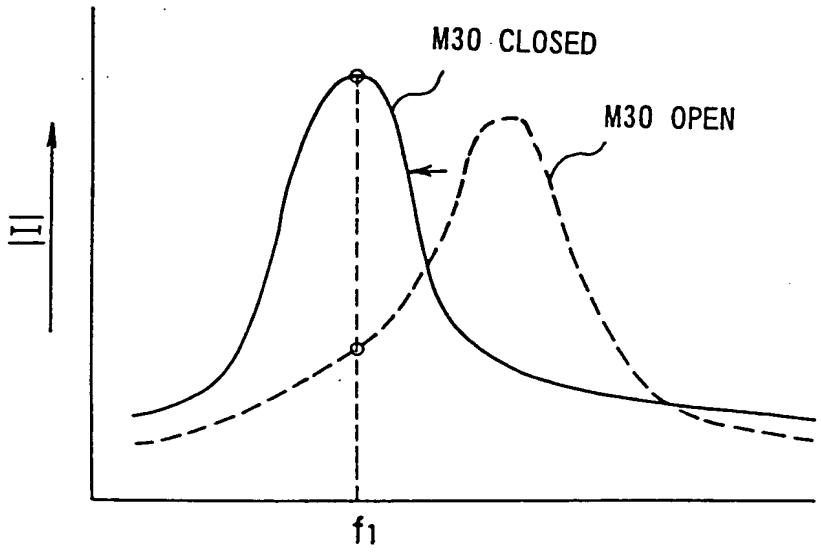


FIG. 37

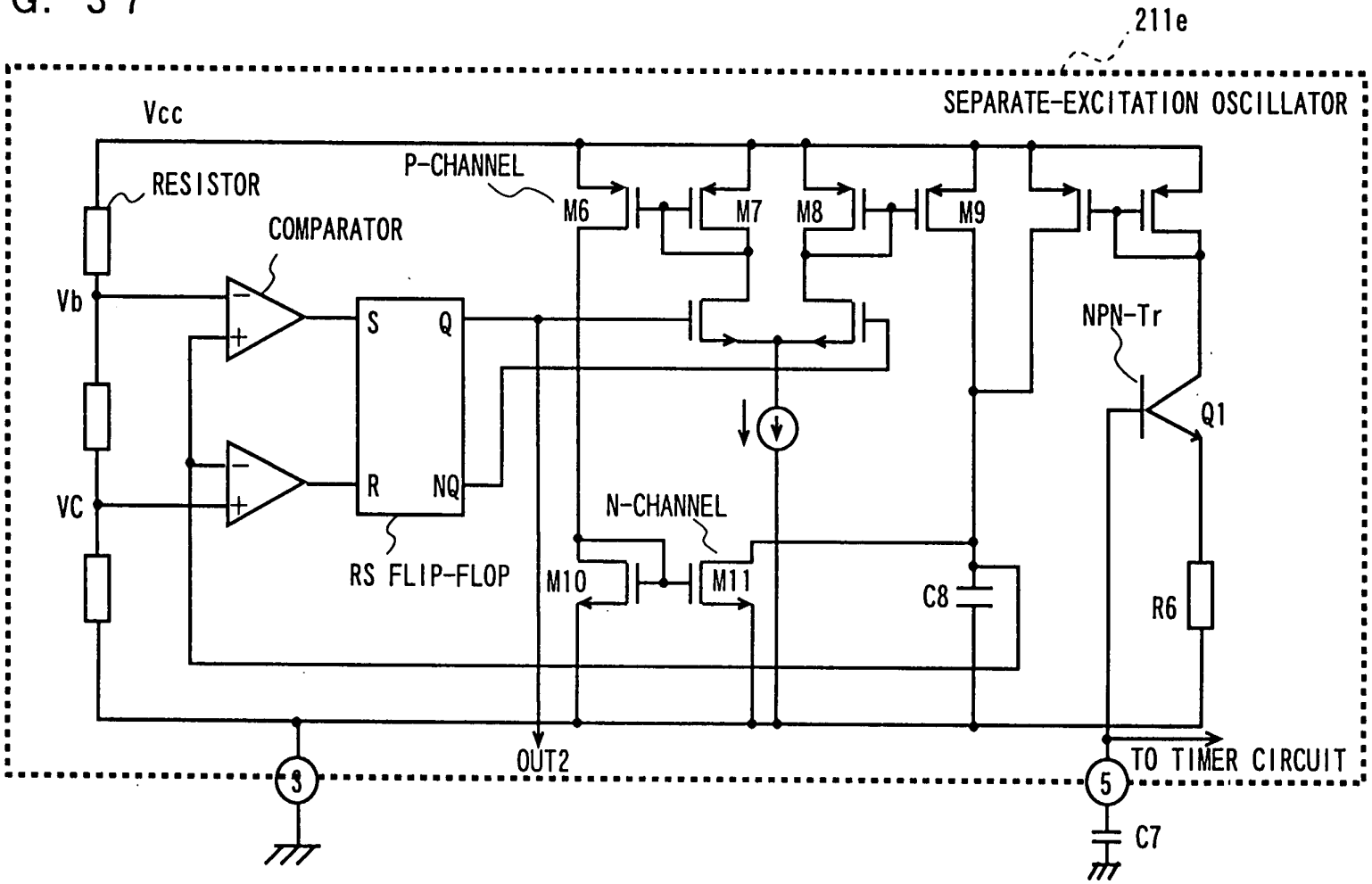

211e
SEPARATE-EXCITATION OSCILLATOR
Vcc
RESISTOR
P-CHANNEL
M6
M7
M8
M9
COMPARATOR
Vb
S
Q
NPN-Tr
Q1
VC
R
NQ
N-CHANNEL
RS FLIP-FLOP
M10
M11
C8
R6
OUT2
TO TIMER CIRCUIT
3
5
C7

FIG. 38

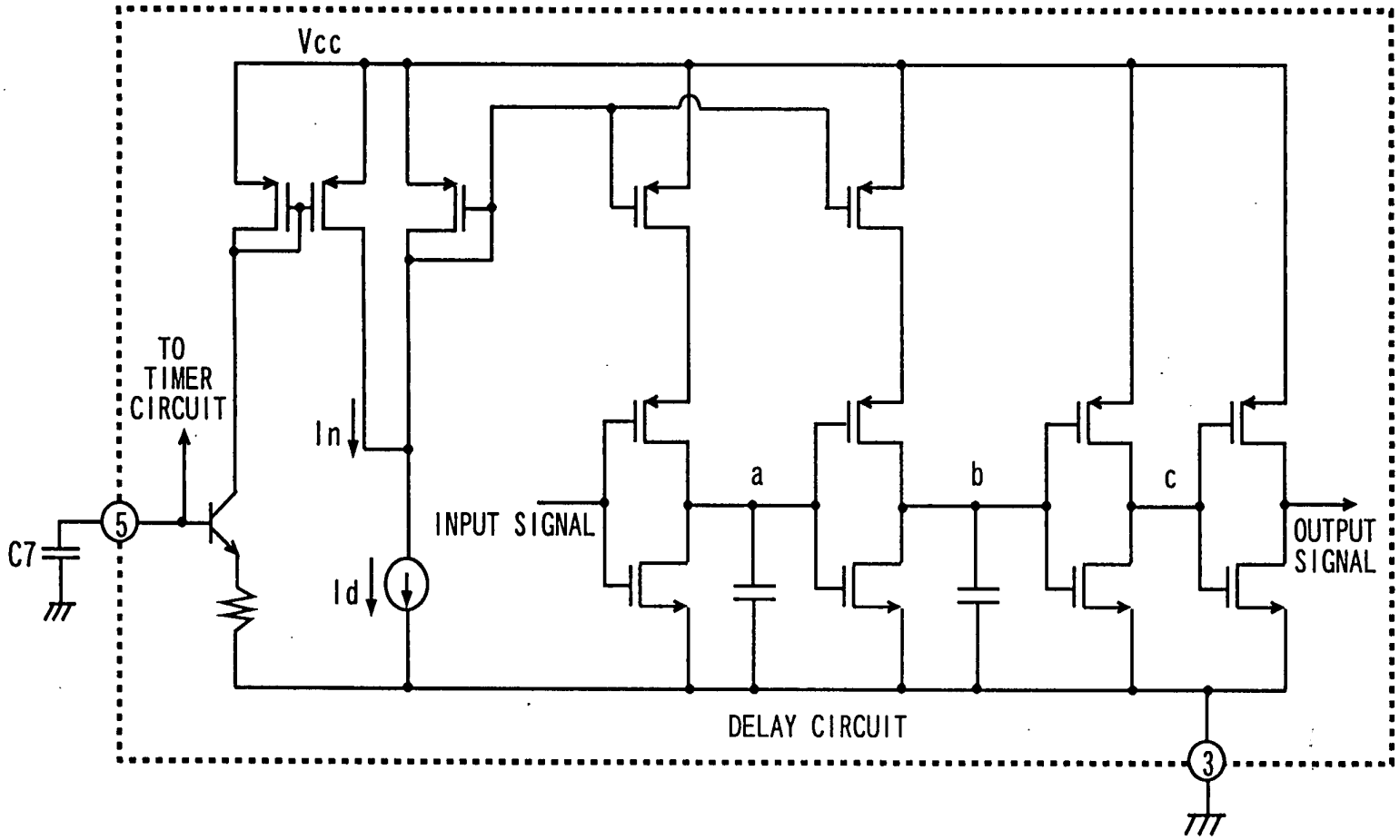

Vcc
TO
TIMER
CIRCUIT
In
Id
C7
5
INPUT SIGNAL
a
b
c
OUTPUT
SIGNAL
DELAY CIRCUIT
3

FIG. 39

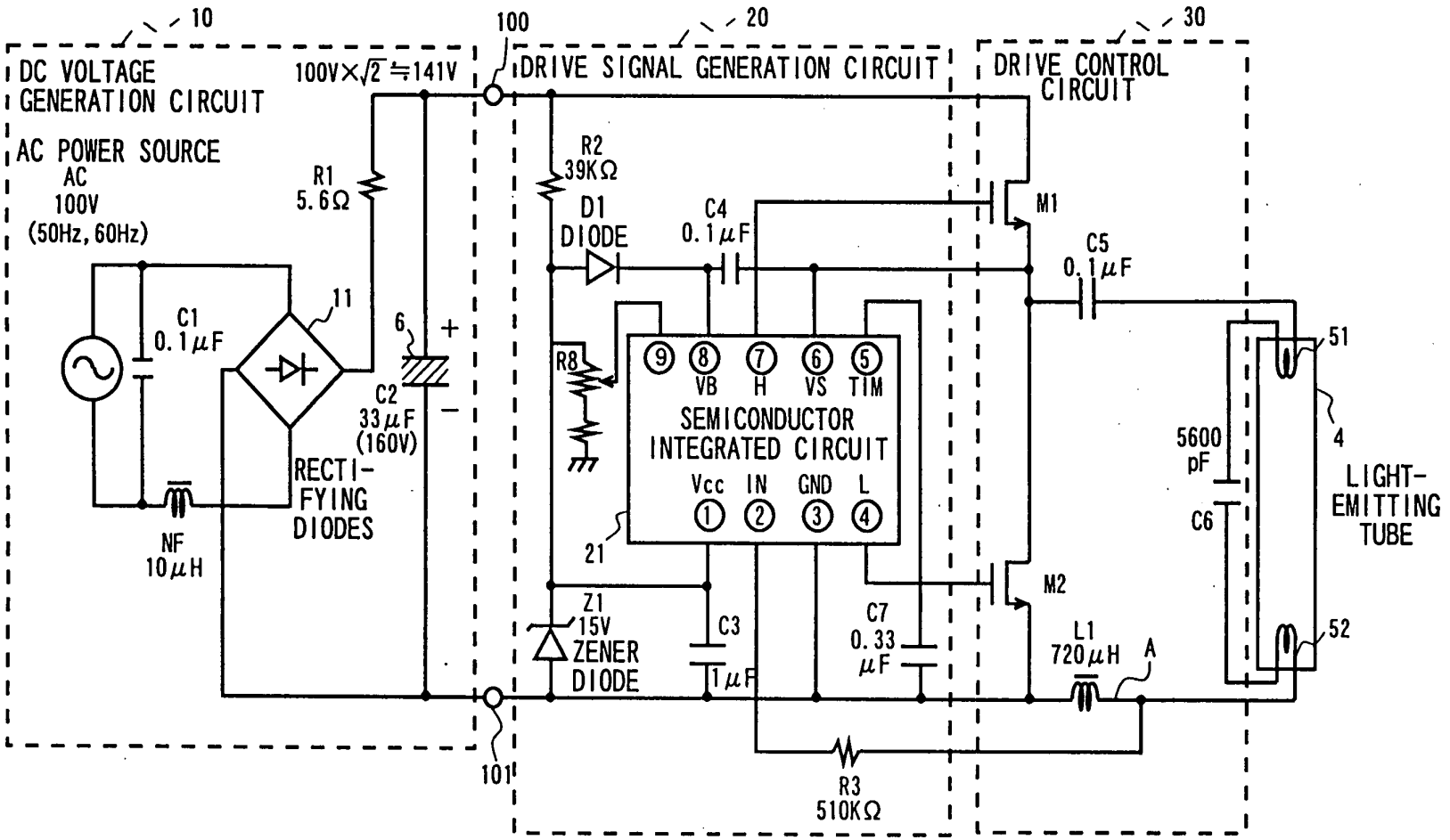

10
DC VOLTAGE GENERATION CIRCUIT
AC POWER SOURCE
AC 100V (50Hz, 60Hz)
C1 0.1μF
NF 10μH
11
RECTI-FYING DIODES
100V×√2 ≒141V
R1 5.6Ω
6
+
−
C2 33μF (160V)
100
101
20
DRIVE SIGNAL GENERATION CIRCUIT
R2 39KΩ
D1 DIODE
C4 0.1μF
R8
9 8 7 6 5
VB H VS TIM
SEMICONDUCTOR INTEGRATED CIRCUIT
Vcc IN GND L
1 2 3 4
21
Z1 15V ZENER DIODE
C3 1μF
C7 0.33 μF
R3 510KΩ
30
DRIVE CONTROL CIRCUIT
M1
M2
C5 0.1μF
L1 720μH
A
51
4
52
5600 pF
C6
LIGHT-EMITTING TUBE

FIG. 40

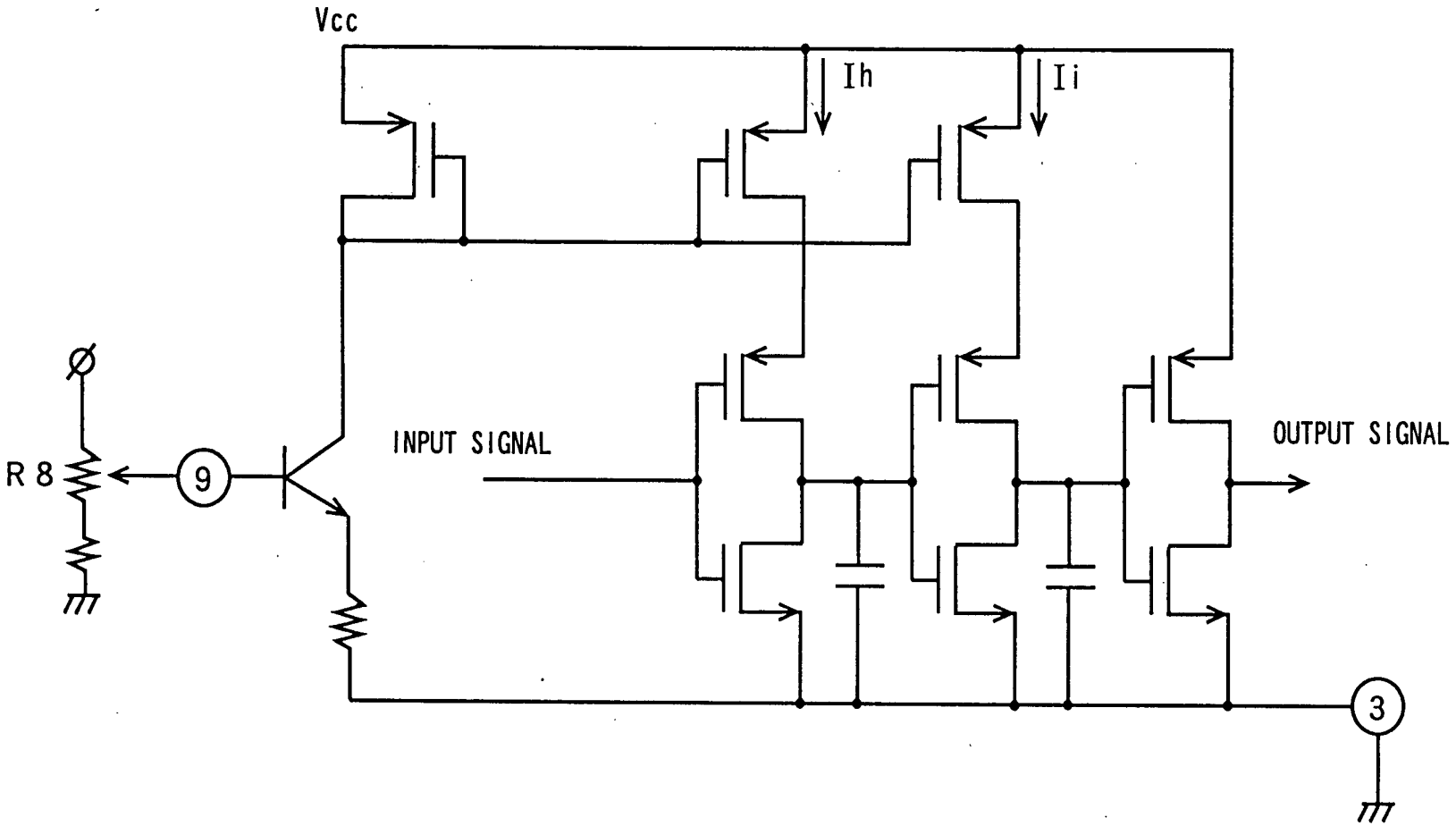


FIG. 41

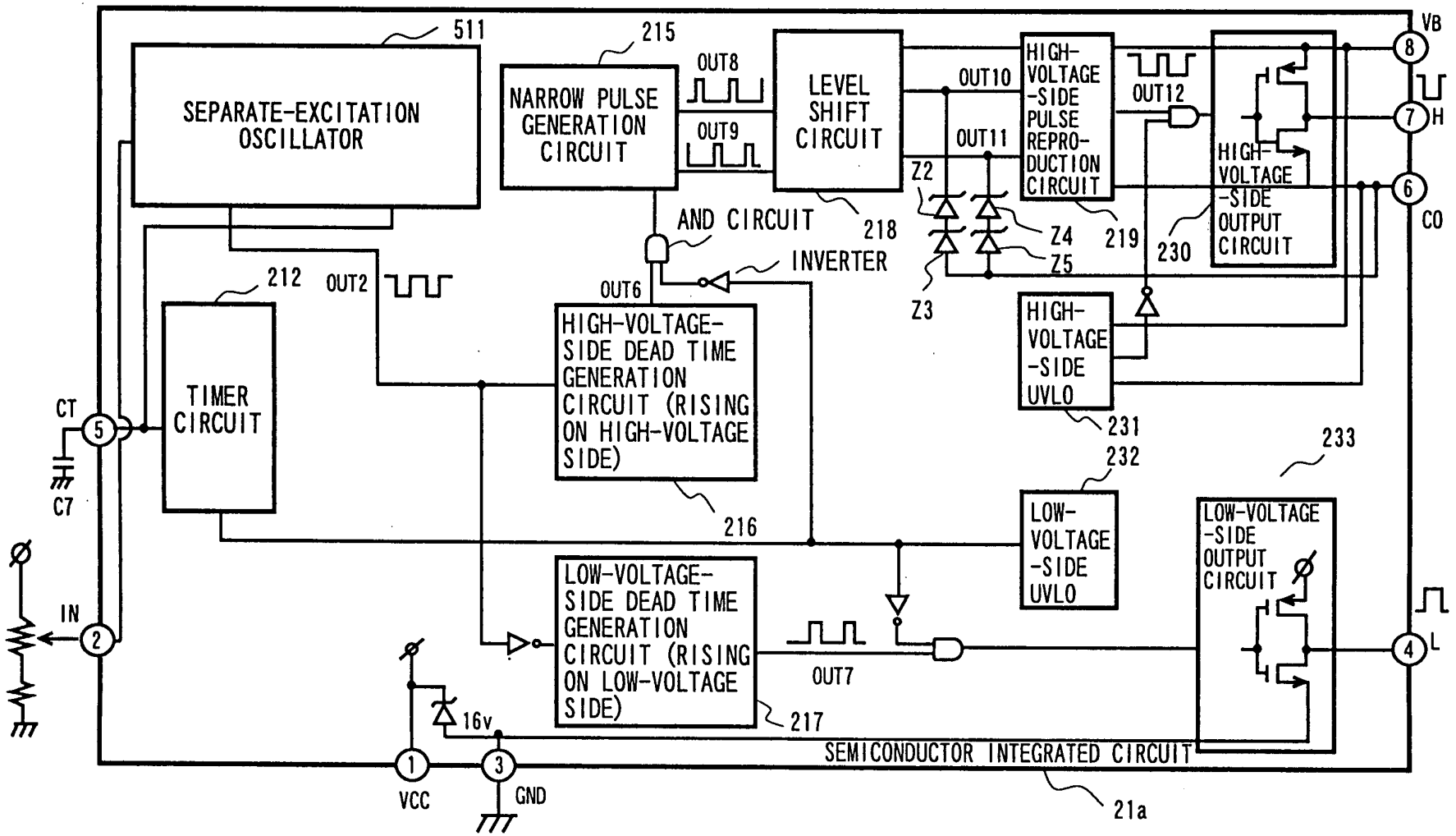

511
SEPARATE-EXCITATION OSCILLATOR
215
NARROW PULSE GENERATION CIRCUIT
OUT8
OUT9
LEVEL SHIFT CIRCUIT
218
OUT10
OUT11
HIGH-VOLTAGE-SIDE PULSE REPRO-DUCTION CIRCUIT
219
OUT12
HIGH-VOLTAGE-SIDE OUTPUT CIRCUIT
230
VB
H
CO
Z2
Z3
Z4
Z5
AND CIRCUIT
INVERTER
212
OUT2
OUT6
TIMER CIRCUIT
HIGH-VOLTAGE-SIDE DEAD TIME GENERATION CIRCUIT (RISING ON HIGH-VOLTAGE SIDE)
216
HIGH-VOLTAGE-SIDE UVLO
231
232
233
LOW-VOLTAGE-SIDE UVLO
LOW-VOLTAGE-SIDE OUTPUT CIRCUIT
L
CT
C7
IN
LOW-VOLTAGE-SIDE DEAD TIME GENERATION CIRCUIT (RISING ON LOW-VOLTAGE SIDE)
217
OUT7
16v
SEMICONDUCTOR INTEGRATED CIRCUIT
21a
VCC
GND

FIG. 42

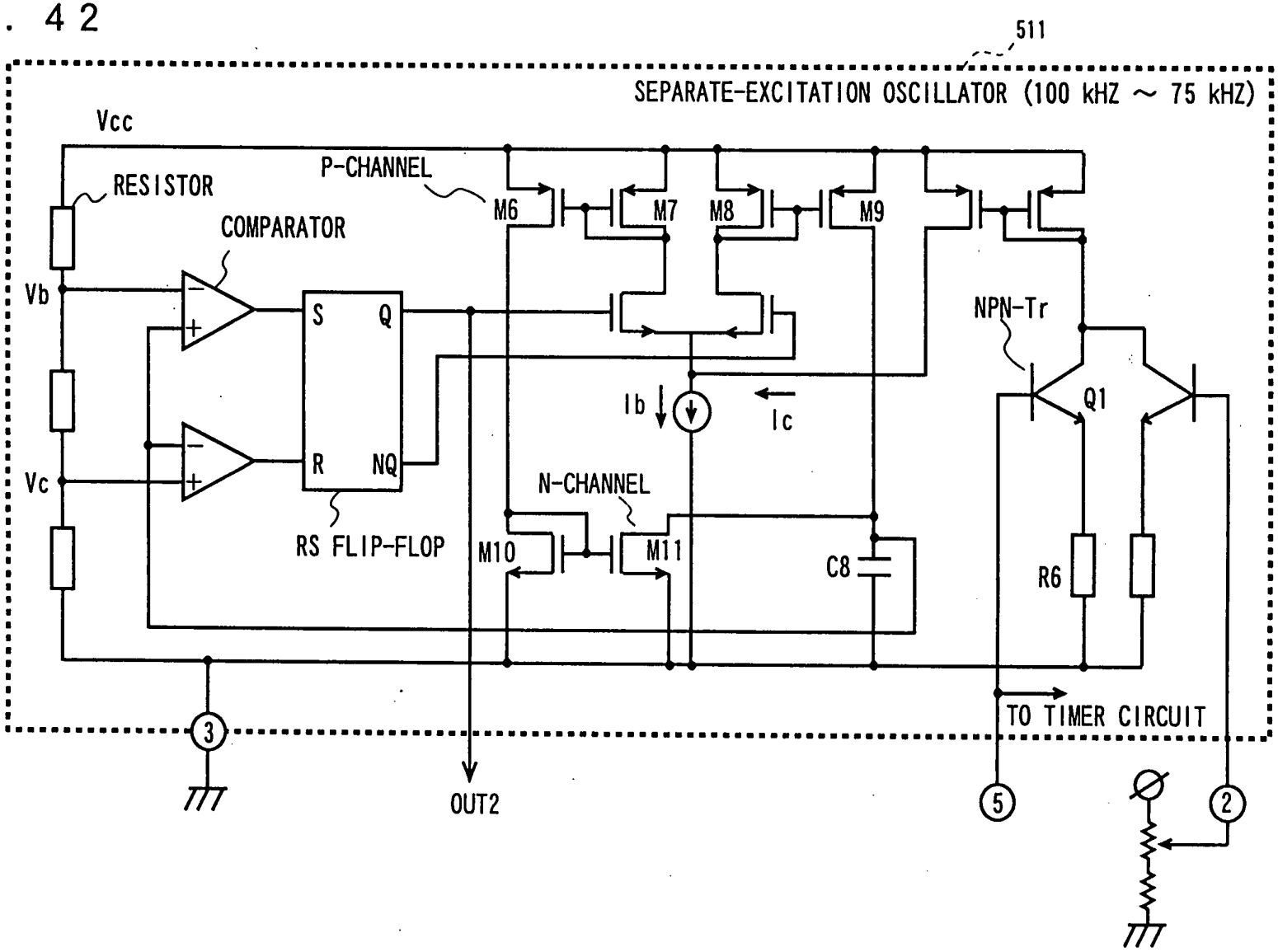

511
SEPARATE-EXCITATION OSCILLATOR (100 kHZ ~ 75 kHZ)
Vcc
RESISTOR
P-CHANNEL
M6
M7
M8
M9
COMPARATOR
Vb
Vc
S
Q
R
NQ
RS FLIP-FLOP
Ib
Ic
NPN-Tr
Q1
N-CHANNEL
M10
M11
C8
R6
TO TIMER CIRCUIT
OUT2
3
5
2

FIG. 43

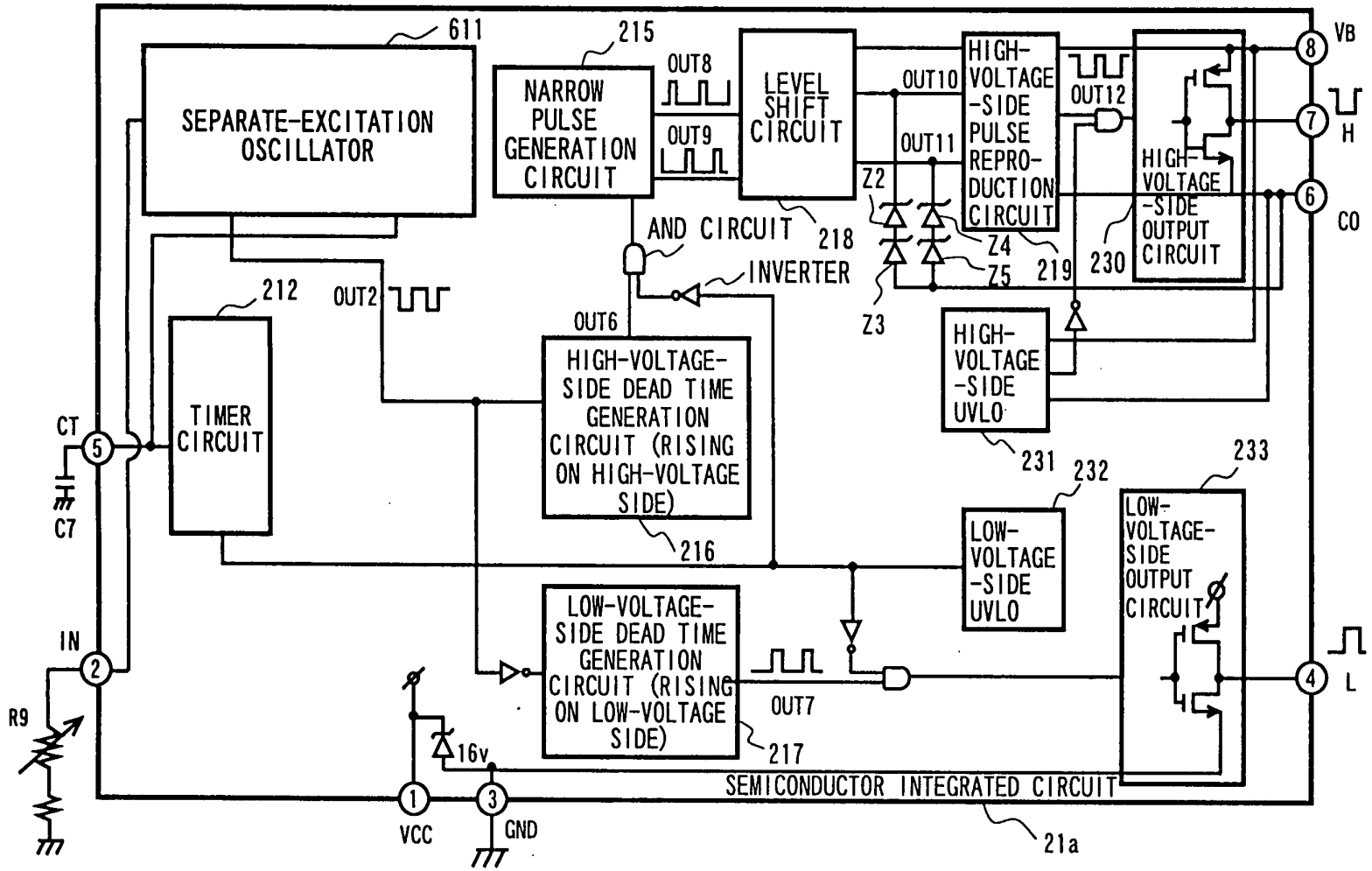

611
SEPARATE-EXCITATION OSCILLATOR
215
NARROW PULSE GENERATION CIRCUIT
OUT8
OUT9
LEVEL SHIFT CIRCUIT
218
OUT10
OUT11
HIGH-VOLTAGE-SIDE PULSE REPRO-DUCTION CIRCUIT
219
OUT12
HIGH-VOLTAGE-SIDE OUTPUT CIRCUIT
230
VB
H
CO
Z2
Z3
Z4
Z5
AND CIRCUIT
INVERTER
212
OUT2
TIMER CIRCUIT
OUT6
HIGH-VOLTAGE-SIDE DEAD TIME GENERATION CIRCUIT (RISING ON HIGH-VOLTAGE SIDE)
216
HIGH-VOLTAGE-SIDE UVLO
231
232
233
LOW-VOLTAGE-SIDE UVLO
LOW-VOLTAGE-SIDE OUTPUT CIRCUIT
L
CT
C7
IN
R9
LOW-VOLTAGE-SIDE DEAD TIME GENERATION CIRCUIT (RISING ON LOW-VOLTAGE SIDE)
OUT7
217
16v
VCC
GND
SEMICONDUCTOR INTEGRATED CIRCUIT
21a

FIG. 44

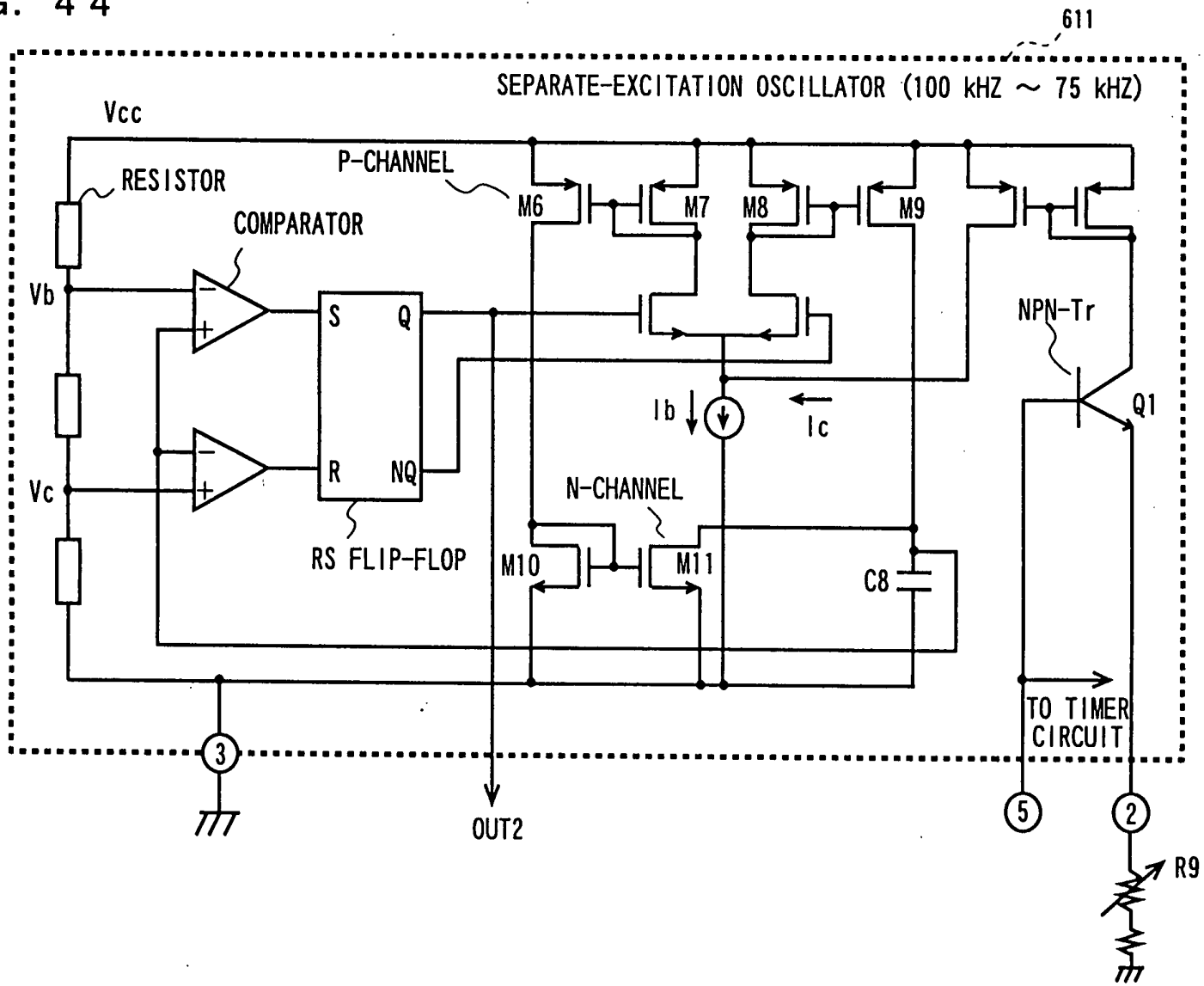

611
SEPARATE-EXCITATION OSCILLATOR (100 kHZ ~ 75 kHZ)
Vcc
RESISTOR
P-CHANNEL
M6
M7
M8
M9
COMPARATOR
Vb
Vc
S
Q
R
NQ
RS FLIP-FLOP
Ib
Ic
NPN-Tr
Q1
N-CHANNEL
M10
M11
C8
TO TIMER CIRCUIT
3
OUT2
5
2
R9

FIG. 45

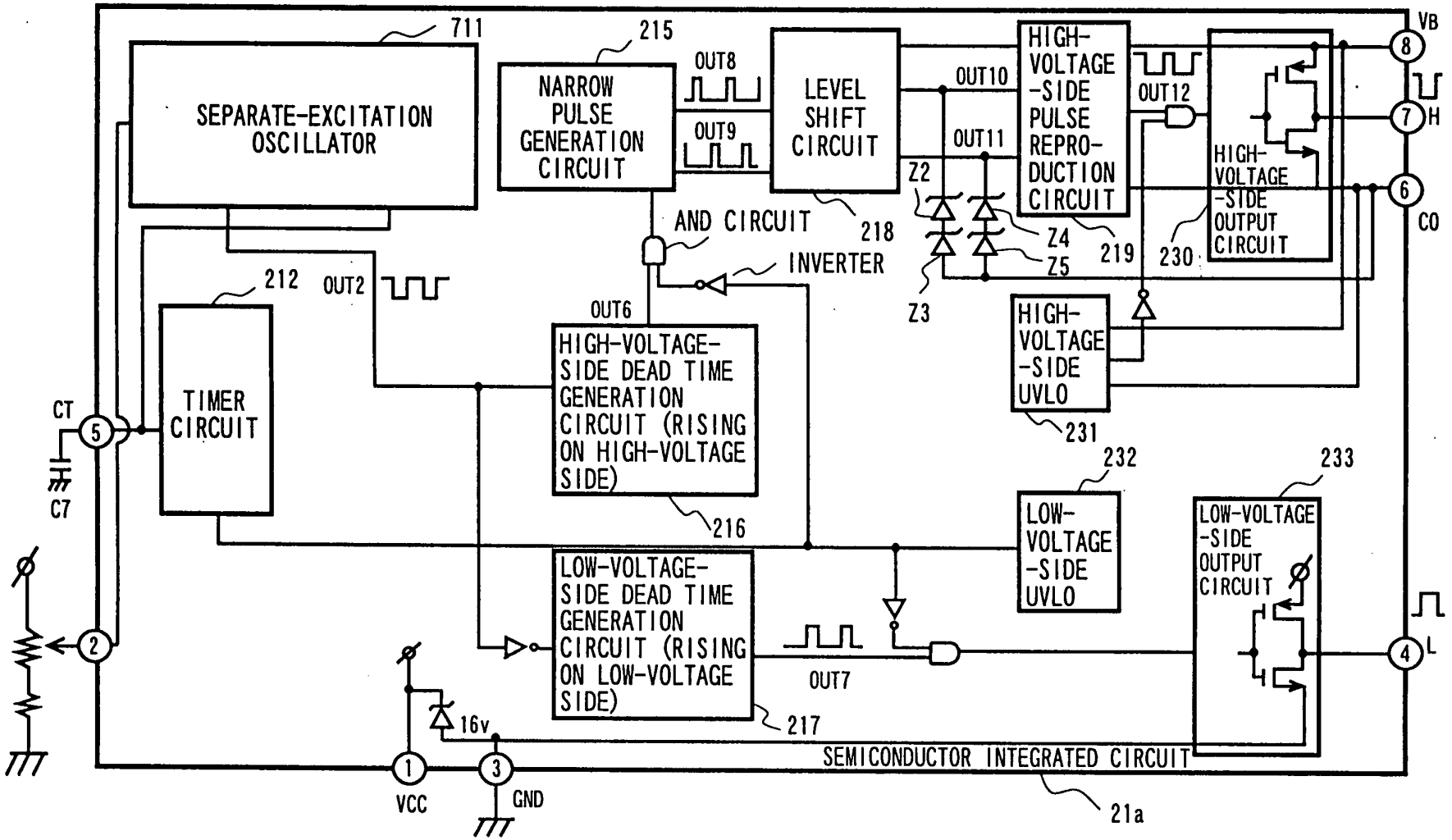
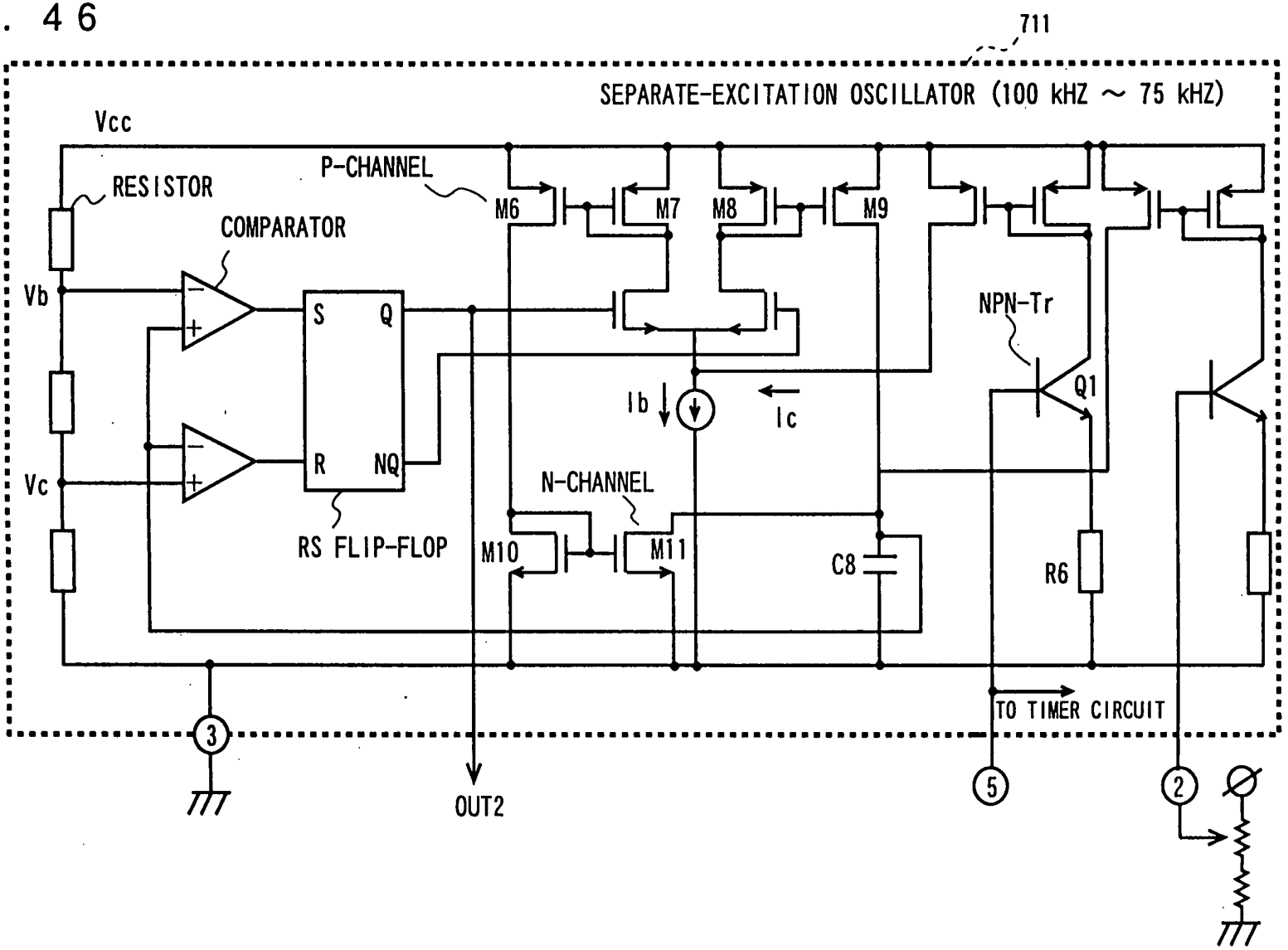

711
SEPARATE-EXCITATION OSCILLATOR
215
NARROW PULSE GENERATION CIRCUIT
OUT8
OUT9
LEVEL SHIFT CIRCUIT
218
OUT10
OUT11
HIGH-VOLTAGE-SIDE PULSE REPRO-DUCTION CIRCUIT
219
OUT12
HIGH-VOLTAGE-SIDE OUTPUT CIRCUIT
230
VB
H
CO
Z2
Z3
Z4
Z5
AND CIRCUIT
INVERTER
212
OUT2
TIMER CIRCUIT
CT
C7
OUT6
HIGH-VOLTAGE-SIDE DEAD TIME GENERATION CIRCUIT (RISING ON HIGH-VOLTAGE SIDE)
216
HIGH-VOLTAGE-SIDE UVLO
231
232
LOW-VOLTAGE-SIDE UVLO
233
LOW-VOLTAGE-SIDE OUTPUT CIRCUIT
L
LOW-VOLTAGE-SIDE DEAD TIME GENERATION CIRCUIT (RISING ON LOW-VOLTAGE SIDE)
OUT7
217
16v
SEMICONDUCTOR INTEGRATED CIRCUIT
21a
VCC
GND

FIG. 46


711
SEPARATE-EXCITATION OSCILLATOR (100 kHZ ~ 75 kHZ)
Vcc
RESISTOR
P-CHANNEL
M6
M7
M8
M9
COMPARATOR
Vb
Vc
S
Q
R
NQ
RS FLIP-FLOP
Ib
Ic
NPN-Tr
Q1
N-CHANNEL
M10
M11
C8
R6
TO TIMER CIRCUIT
OUT2
3
5
2

F I G. 4 7

PRIOR ART